sustainability

Review

A Systematic Review of Green Building Development in China: Advantages, Challenges and Future Directions

Yu Cao [1,†], Cong Xu [2,*,†], Syahrul Nizam Kamaruzzaman [1,*] and Nur Mardhiyah Aziz [1]

[1] Faculty of Built Environment, University of Malaya, Kuala Lumpur 50603, Malaysia
[2] Seoul School of Integrated Sciences and Technologies, Seoul 03767, Korea
* Correspondence: xucong@stud.assist.ac.kr (C.X.); syahrulnizam@um.edu.my (S.N.K.)
† These authors contributed equally to this work.

Abstract: In the 21st century, traditional construction activities exert a severe negative influence on the environment and ecology. To mitigate the negative influence of construction, green buildings have received increasing attention worldwide. Compared with conventional buildings, green buildings have significant advantages for environmental conservation and public health. Although green buildings bring excellent benefits, the development status of green buildings in China is still unsatisfactory. To enhance the understanding of green buildings and promote green building development in China, this study was undertaken to conduct a systematic review of green building development in China. The PRISMA protocol was used as the primary procedure for article screening and selection. This review was conducted between March 2022 and May 2022. In this study, 186 articles were reviewed, and the definition, development trends, evaluation standards, importance, and hindrances of green buildings in China were summarized and discussed through the systematic review. Moreover, the benefits, challenges, and future directions of green building promotion and development in China were discussed and analyzed. This study can promote public familiarity with the current situation of green buildings in China to boost their development. In addition, this study can also provide practical advice to green building stakeholders on the future direction of green building development in China.

Keywords: green building; sustainable building; sustainability; environmental protection

check for updates

Citation: Cao, Y.; Xu, C.; Kamaruzzaman, S.N.; Aziz, N.M. A Systematic Review of Green Building Development in China: Advantages, Challenges and Future Directions. *Sustainability* **2022**, *14*, 12293. https://doi.org/10.3390/su141912293

Academic Editors: Nan Zhang, Lingkun Chen and Qinghua Zhang

Received: 2 September 2022
Accepted: 25 September 2022
Published: 27 September 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

In the 21st century, the construction industry has exerted a considerable negative impact on environmental conservation and sustainable development worldwide. According to the report of the Global Alliance for Buildings and Construction, the building sector accounted for 36% of global end-use energy consumption and 37% of global energy-related CO_2 emissions in 2020 [1]. Moreover, the emissions intensity and energy intensity related to buildings were, respectively, 48 $KgCO_2/M^2$ and 606 MJ/m^2 in 2020 [1]. In China, the pollution and toxic gas emissions caused by construction activities are severe [2–4]. Due to the enormous construction activities in China, the average PM10 (inhalable particles with diameters of at most 10 μm) emission density reached 69 $\mu g/m^3$ in 2021 [5]. Moreover, the building and construction sectors produce over 10% of contaminated particulates [6]. Given the severe pollution and toxic gas emissions caused by the building sector, a large number of residents suffer from respiratory diseases, pneumoconiosis, heart disease, and lung cancer [7,8].

Green building is deemed a vital method to mitigate the negative influence caused by construction activities. According to the Evaluation Standard of Green Building in China, green buildings are buildings that provide environmental benignity, energy savings, pollution reduction, healthy residential environments, and comfortable utilization experiences throughout the entire lifecycle of the asset [9]. Compared to conventional architecture, green buildings have some significant advantages and benefits, including a low negative environmental impact, no toxic gas emissions, a preference for recycled materials and renewable energy utilization, and high residential satisfaction [10,11]. Based on the abovementioned contributions, green buildings have significant advantages regarding environmental protection and public health optimization.

Despite the significant advantages and benefits of green buildings for environmental protection and ecological improvement, compared to developed countries, the development situation of green buildings is relatively backward in China. According to the report of the China Real Estate Association, only 14.9% of certificated green buildings were three-star green buildings in 2018, and 48% of green buildings can meet only the lowest level of green building requirements [12,13]. Moreover, only 4.5% of buildings obtain the green building operation certification in China [13,14]. A significant impediment to the development of green buildings in China is the insufficient understanding of green buildings [14–16]. As a form of construction requiring innovative technology, the local governments and construction companies are not familiar enough with this approach. This obstacle leads to a relative lag in the development of green buildings in China [17,18]. In addition to the lack of familiarity with green buildings, the unclear future direction of green buildings is also a significant impediment to the green buildings' promotion. The vague future paths lead to substantial financial wastage and insufficient confidence among green-building-related stakeholders. According to Chan et al. [19] and Kasai and Jabbour [20], the major barriers to green building development in developing countries are the lack of understanding of green buildings and the immature green building development measures. Shen et al. [21] pointed out that public familiarity and a proper direction for development are the critical success factors for the development of green buildings in developing countries. The lack of public familiarity with green construction and future trends can lead to the insufficient confidence of AEC (Architecture, Engineering and Construction) industry personnel in green buildings, which hinders the development of green buildings in China [22–25].

Based on the abovementioned background, to promote the development of green buildings in China, it is necessary to review the green building development status in China and explore the future development directions of green buildings in the country. There have been some articles that summarize the development status of green buildings in China [11,14,26–34]. Huang et al. [27] and Wu et al. [14] revealed the obstacles to green building promotion and development in China. Lu et al. [11] and Wang [30] explored the construction technologies that can be utilized in green buildings. Moreover, Zhao et al. [33] summarized the building information modeling (BIM) utilization method in the design phase of green buildings. Besides these, Guo et al. [26] and Yang et al. [31] reviewed the assessment frameworks of green buildings. However, most of the abovementioned articles focus on specific aspects or areas of green building development, instead of providing comprehensive reviews of the development status and future trends of green buildings in China. Moreover, the majority of these reviewed articles do not include systematic literature reviews. Compared to the traditional literature review, the systematic review can support other scholars in integrating available information and providing data for decision making through effective patterns [35]. Furthermore, systematic reviews can determine whether the scientific findings are consistent and can be generalized across the green buildings located in various countries [36–39]. In addition, the fixed article screening and analysis procedure utilized in the systematic literature review can support the researchers in eliminating bias and enhance the precision and reliability of conclusions [35,40].

To fill the abovementioned research gap, it is necessary to perform a study to review the green buildings in China and explore the future directions of green building development in China. Thus, given the background mentioned above, this study was developed to conduct a systematic review of green building development in China. To complete this systematic review and achieve the abovementioned aim in this study, the following research questions were developed:

1. What is the development situation of green buildings in China?

2. What are the advantages and disadvantages of green building development in China?
3. What is the future direction of green building development in China?

To solve the abovementioned research questions, the following research objectives were developed by the authors:

1. To identify the development situation of green buildings in China;
2. To discuss and analyze the benefits and challenges to the development of green buildings in China;
3. To summarize the future directions of green buildings in China.

There are five sections in this study. Section 1 is the introduction. The research background, problem statement, research aim, research questions, and research objectives are demonstrated in Section 1. The research methodology is presented in Section 2. Section 3 includes the results of this systematic review. Moreover, the benefits, challenges, and future directions of green building development in China are shown in Section 4. Then, the conclusion of this study is demonstrated in Section 5. In Section 5, the advantages, challenges, and future directions of green building development in China are also presented.

2. Methodology

The systematic literature review approach is adopted to perform this study. As an effective review method, the systematic review can enable researchers to identify and screen the evidence relevant to specific issues or questions and appraise and summarize the research outcomes of the review to be applied in practice, regulations, and further studies [41–45]. According to Aromataris and Pearson [46], Munn et al. [47], and Pearson [48], the systematic review has significant contributions in the following aspects: revealing the potential evidence or rules; confirming the current method or procedure/resolving any discrepancies/determining new practices; identifying the direction for future studies or further research; identifying and analyzing the conflicts of the research results in different studies; developing guidance for decision making.

To conduct the systematic review, the preferred reporting items for systematic reviews and meta-analyses (PRISMA) model [49] is adopted in this study. There are four steps in the process of PRISMA, as in the reviews that were conducted by Cao et al. [50], Regona et al. [51], and Yigitcanlar et al. [52]. The steps of PRISMA that are conducted in this study are presented below:

1. Determine the databases and keywords that are utilized in the process of article searching and retrieval.
2. Put forward the search strings and inclusion and exclusion criteria adopted in the article search and screening in this study; moreover, the preliminary articles' retrieval and screening are conducted based on the abovementioned search strings and criteria.
3. Perform the qualitative screening of retrieved articles by reviewing their titles, keywords, and abstracts (check which articles meet the inclusion criteria).
4. Conduct the full-text review of the remaining articles.

The detailed procedure of the systematic review in studies contains three phases: planning stage, review stage, and categorization stage.

Planning stage (Stage 1): Scopus and Web of Science (WoS) are adopted as the databases in this study. In the process of article searching, the searched articles included conference papers, articles, review articles, books, book chapters, conference reviews, and proceedings papers that could be retrieved in WoS and Scopus. Given the limitations of the authors' language skills, non-English articles were not permitted to be included in this study. Moreover, studies that did not perform peer review could not be included in this study. The keywords that were utilized in the process of article search and retrieval are presented below: "green building", "the development of green building in China", "green building evaluation standard", "green building assessment", "green building importance", "green building contribution", and "green building barriers".

Moreover, the research strings (as shown in Table 1) are prepared in this stage for the article search and retrieval process (Stage 2). Besides this, the inclusion criteria and exclusion criteria (as presented in Table 2) are also developed in the planning stage to be utilized for the further article screening and selection.

Table 1. The search string and the results of article filtering in this study.

Databases	Search String	Results
WoS	TS= ((“green building” AND “develop”) OR (“green building” AND “evaluation”) OR (“green building” AND “importance”) OR (“green building” AND “barrier”) OR (“green building” AND “obstacle”))	1027
	Document Types: Proceedings Papers or Articles or Review Articles or Book	975
	AND LANGUAGES: (ENGLISH)	962
Scopus	TITLE-ABS-KEY ((“green building” AND “develop”) OR (“green building” AND “evaluation”) OR (“green building” AND “importance”) OR (“green building” AND “barrier”) OR (“green building” AND “obstacle”))	1136
	AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “cp”) OR LIMIT-TO (DOCTYPE, “re”) OR LIMIT-TO (DOCTYPE, “ch”) OR LIMIT-TO (DOCTYPE, “cr”) OR LIMIT-TO (DOCTYPE, “bk”))	1087
	AND (LIMIT-TO (LANGUAGE, “English”))	1065
Number of articles that passed the initial retrieval = 2027 Duplicated studies= 138 Invalid articles = 175 After eliminating duplicated studies and invalid articles = 1714 After title and keyword screening = 742 After abstract screening = 391 After full-text review screening = 186 Total = 186		

Table 2. Inclusion criteria and exclusion criteria.

Primary Criteria		Secondary Criteria	
Inclusionary	**Exclusionary**	**Inclusionary**	**Exclusionary**
Journal articles that are retrievable in Scopus or WoS	Duplicated studies	Articles containing contents that are related to the keywords	Articles containing contents that are not related to the keywords
Conference papers and proceeding papers that are retrievable in Scopus or WoS	Invalid articles (articles for which full-text content is not available online)	Studies that can assist the authors in fulfilling the research objectives	Studies that cannot assist the authors in fulfilling the research objectives
Review articles that that are retrievable in Scopus or WoS			
Books or book chapters that are retrievable in Scopus or WoS			
Written in English	Written in non-English languages		

Conducting the review stage (Stage 2): The article search and screening were conducted between March 2022 and May 2022. Through the preliminary article search based on the search strings that are presented in Table 1, there were 2027 articles (962 in WoS and 1065 in Scopus) retrieved by the researchers (excluding the articles written in non-English languages and not in the required format). In the next step, 138 duplicated articles and 175 invalid articles were removed. Thus, 1714 articles remained after the elimination of duplications and invalid papers. Then, based on the inclusion criterion and exclusion criterion that are mentioned in Table 2, the remaining 1714 articles were subjected to qualitative screening by reviewing their titles and keywords. In this step, 972 articles were excluded because their titles or keywords could not be matched with the research aim and objectives in this study. Thus, 742 articles remained after the screening of titles and keywords. Then, these 742 articles were subjected to the further quality screening by inspecting their abstracts based on the inclusion criterion and exclusion criterion (as shown in Table 2), and 351 articles were removed due to mismatched abstracts. In the next step, the researchers conducted a full-text review of the remaining 391 articles based on the inclusion criterion and exclusion criterion (as demonstrated in Table 2). In this process, 205 articles were excluded because of the insufficient quality or mismatched directions of their contents. Finally, 186 articles were included in this study.

Categorization stage (stage 3): In Stage 3, the remaining 186 articles were categorized according to their content. Through categorization, it can be identified that the content of these remaining articles covers the following perspectives:

- The definition of the green building;
- The trend of green buildings in China;
- Green building assessment systems in China;
- The importance of green buildings;
- Green building development barriers in China.

The process of classification is shown in Table 3.

Table 3. The procedure of developing the research results' classification.

Identify the green-building-related information by reviewing the content of included articles.
Categorize the articles according to their contribution areas from the green building perspective.
Identify the domains of green buildings that are covered in these articles.
Test the consistency by comparing with other studies.
Verify the classification that is formulated in this research.

Before green buildings were introduced into China, green buildings originated and experienced favorable development in developed countries. To provide a more comprehensive review of the definitions' evolution and the development trends of green buildings in China, some articles that focus on the definition and history of green buildings in developed countries, instead of China, are also included in the study. Moreover, the authors of the green building assessment framework in China took into account the green building evaluation standards of developed countries in their compilation process. To provide a comprehensive review of green building assessment standards in China and develop an effective comparison of green building assessment standards in China with green building evaluation frameworks in other developed countries, the articles that discussed the green building evaluation standards in developed countries are also included in the study. The entire process of article searching and screening in this study is presented in Figure 1.

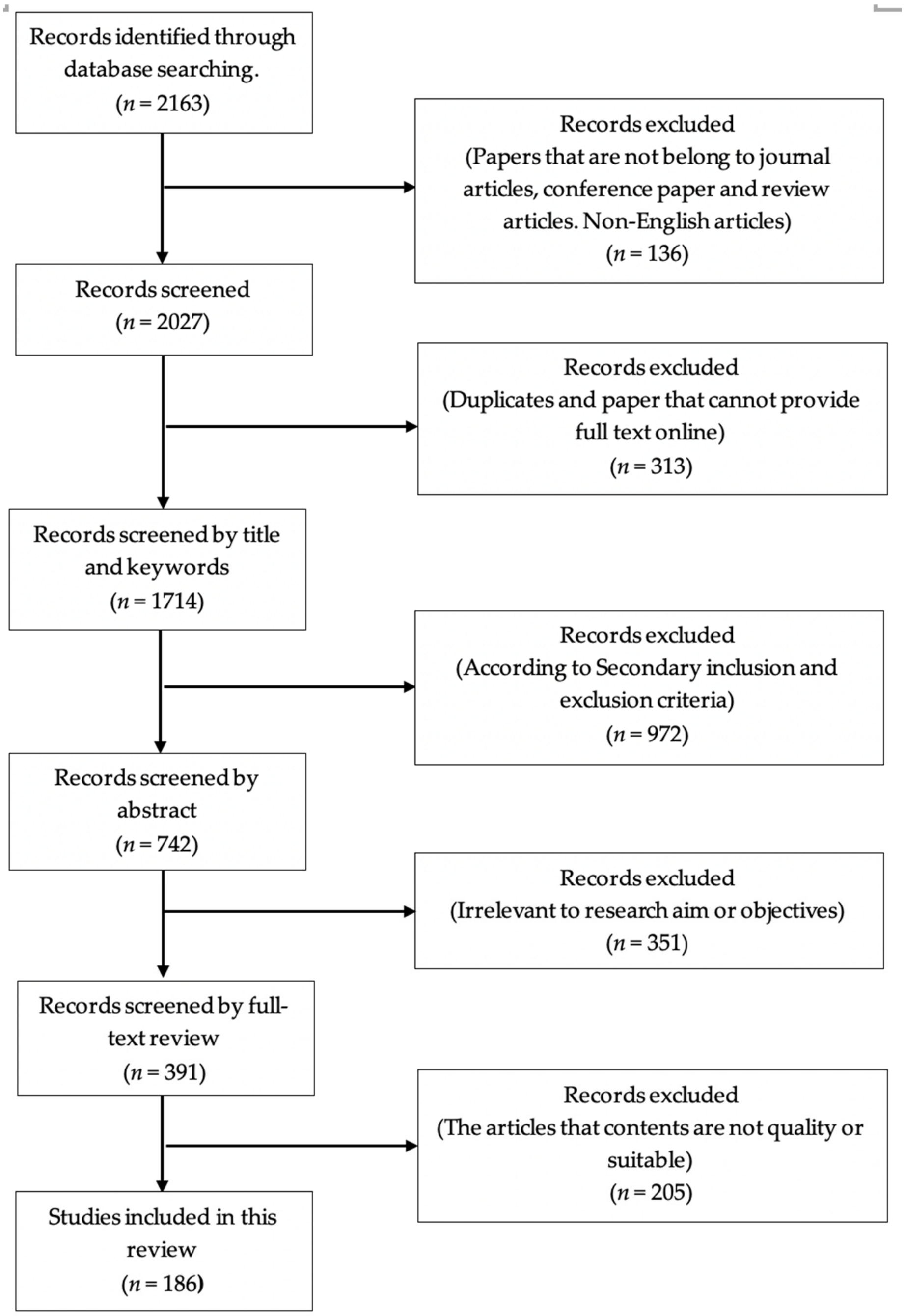

Figure 1. The flow chart of article searching and screening in this study.

3. Results

3.1. Descriptive Analysis

Through the article retrieval and screening described in Section 2, there were 186 articles included in this study. After the article search and screening procedure was completed, these selected studies were subjected to the systematic review through reading their full texts. The articles published per year are presented in Figure 2.

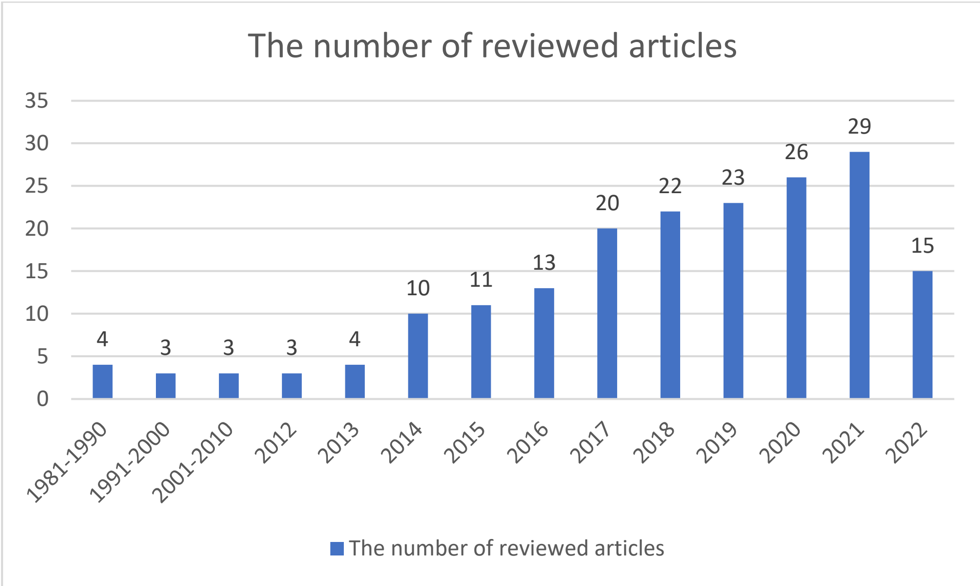

Figure 2. The quantity of articles published per year.

Through the systematic review of the included articles, it could be identified that the reviewed articles on green buildings date back to the 1980s. Between 1980 and 2010, green buildings have gained some attention worldwide. In this study, the number of included articles in each decade from 1981 to 2010 was less than five. There were less than five reviewed articles published in 2012 and 2013. Research on green buildings' development and promotion in China gradually advanced in this period. Between 2014 and 2016, there was a significant increase in green building development in China. Over 10 reviewed articles were published per year from 2014 to 2016. Since 2017, the studies on green building development in China have been dramatically improved and attracted significant attention from the research industry. In this period, the quantity of related articles published has continuously increased (from 20 in 2017 to 29 in 2021). This indicates that green buildings have become the primary research domain in China.

The article search and screening process was conducted between March 2022 and May 2022, so the articles published after May 2022 were not included in this study. The limitation of the research duration led to an insufficient quantity of included articles that were published in 2022. Thus, despite only 15 reviewed articles published in 2022, it cannot be concluded that the green building research declined in China in 2022. Moreover, given that 15 articles published in the first five months of 2022 alone are included in this study, this phenomenon can indirectly indicate that green buildings are still essential and relevant in 2022.

From the perspective of the publication source, it can be identified that the reviewed studies were retrieved from 67 journals, 14 conferences, and 10 books. The ranking of the journals in which articles were published is demonstrated in Figure 3 (due to the length limitation of Figure 2, only the top ten journals/conferences/books with the highest number of articles in this study are included).

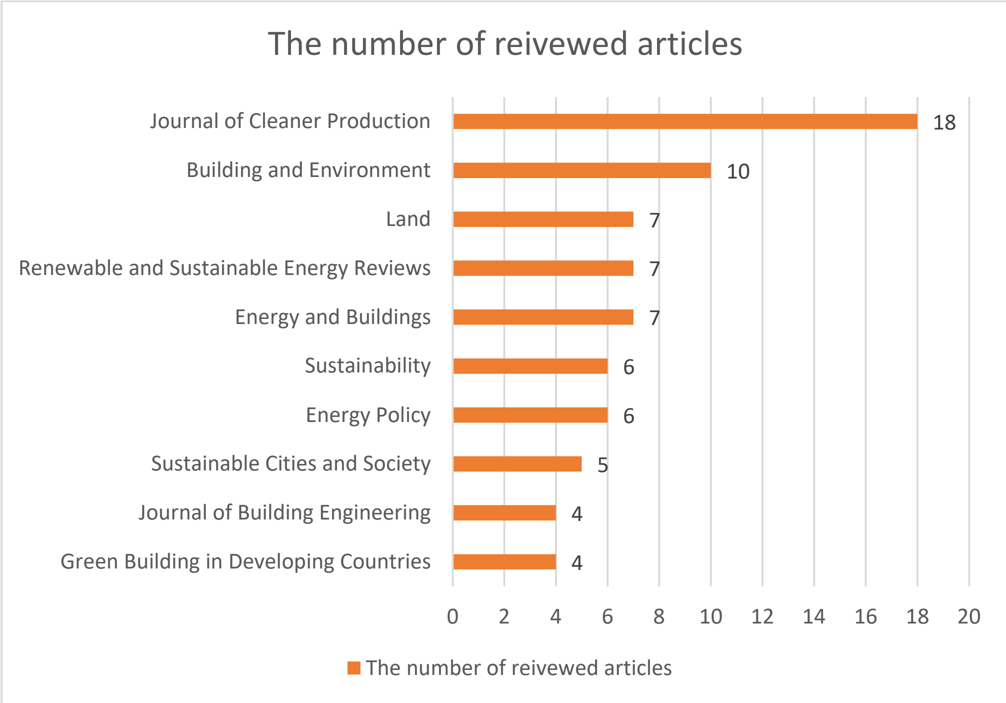

Figure 3. Number of papers published per journal/book/conference.

3.2. Result Analysis

After performing the systematic review of the contained articles, the content of these articles could be categorized into five categories, including the definition of green buildings; the trend of green buildings in China; green building assessment systems in China; the importance of green buildings; green building development barriers in China.

3.2.1. Definition of Green Building

The green building can be dated back to the 1960s. In 1969, the concept of the "ecological building" was developed by American architect Ian Lennox McHarg in the publication "Design with Nature" [53–55]. According to the United States Environmental Protection Agency (EPA), due to the energy crisis, the optimization of energy conservation and development of renewable energy sources became a significant trend in the USA and Europe in the 1970s [56,57]. This issue led to the earliest experiments with contemporary green buildings [56,57]. In 1975, "Energy-Saving in Design for New Building" was developed by ASHRAE (American Society of Heating Refrigerating and Airconditioning Engineers). This was the first contemporary green building standard [58]. In the 1980s, the United Nations Environment Program published the "Our Common Future" report, which signified the formal establishment of sustainable conceptual development [59–62]. In 1992, the Environmental Resource Guide and Energy Star program was formulated by the American Institute of Architects (AIA) and EPA. Green buildings gradually became the direction of development in developed countries [63]. Since the 1990s, various green building assessment standards have been formulated in developed and developing countries, such as the USA, Britain, Canada, Australia, Japan, Singapore, and China [56,64–68].

There is an international definition of green buildings. According to the World Green Building Council [69], green buildings are assets that can reduce negative impacts on the natural environment in their design, construction, operation and maintenance, and demolition phases. In this definition, green buildings obtain the following characteristics: resources and energy conservation; a preference for renewable energy, such as wind, solar, and hydropower; a reduction in pollution and waste production; a preference for safe and recyclable materials; high environmental quality and residential comfort; complementarity to the local natural environment and ecology [11,67,70].

The definitions of green buildings display diversity in different countries and organizations [71–76]. The US Green Building Council [77] defined green buildings as an effort to provide a comfortable living experience and reduce the damage to the ecology and environment in their entire lifecycle. The EPA [78–80] stated that a "green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout." Besides the abovementioned concepts, the Singapore Green Building Council (SGBC) stated that the concept of green buildings should include education enhancement, job creation, community improvement, and health protection [81]. In China, the definition of green buildings can be summarized as "Four Savings and One Benign", which states that Chinese green buildings should be energy-saving, land-saving, water-saving, material-saving, and environmentally benign [82–87]. In this definition, energy saving does not only mean a reduction in energy consumption, but also the use of clean and non-fossil-based energy sources [9,88]. From the viewpoint of land saving, green buildings are required to reduce ecological land occupation and ruin [9]. From the perspective of water and energy, it is necessary for the green buildings in China to adopt wastewater purification technologies to increase water recycling, instead of merely minimizing their water consumption [9,89,90]. Further, from the viewpoint of environmental benignity, it is essential for the green buildings to be suitably integrated into the local ecology and environment, and the green buildings and the environment are required to have reciprocal benefits in their lifecycle [9,89–91].

In addition to environmental conservation, green buildings also have requirements in terms of economic and social aspects. From the perspective of economic and expenditure, green buildings are required to reduce their direct costs, indirect costs, maintenance costs, and construction time throughout their lifecycle [92,93]. From a social perspective, green buildings need to provide residents with a comfortable residential experience and enhance their comfort and happiness [9].

Above all, despite differences in various definitions, there are also standard features among these definitions. These features can be summarized as lower lifecycle costs, lower pollution emissions, lower negative effects on the environment, lower utilization of non-renewable energy resources, and better building quality and residential comfort.

3.2.2. The Trend of Green Buildings in China

Compared with developed countries, the development of green buildings in China was relatively late. In 1986, "Energy-Saving Design Standards for Civil Buildings" was published by MOHURD (Ministry of Housing and Urban-Rural Development of China) [68,70,94]. With this, the concept of energy conservation was formally introduced in the Chinese AEC industry [68]. In 1996, the "New Urban Building Energy Efficient Standard System" was issued, which effectively improved the standardization of energy-efficient methods in China [70,95,96]. In 2003, Tsinghua University drafted the "Green Building Assessment System", and "green building" was formally developed as an industry term in this report. This was followed by the establishment of the "Evaluation Standards for Green Building (Version 1)" [70,97,98], marking the beginning of the official promotion of green buildings in China.

Although the development and promotion of green buildings was relatively late, the tremendous benefits of green buildings encouraged the Chinese government to promote the development of green buildings strongly. From a policy perspective, the Chinese government provided a significant contribution to green buildings. The promotion of green buildings and green construction was settled as an essential developmental aspect by the Chinese central government in the National Economic and Social Development Planning Outline for 2011–2015 [68]. The National People's Congress (2011) stated that the energy efficiency rate should reach 65% in major cities (such as Peking and Shanghai). MOHURD put forward "The 13th Five-Year Plan for the Development of the Construction

Industry", which stipulates that the proportion of green buildings in new construction should reach 50%. The proportion of environmental materials adopted should reach at least 40% of the entire projects in 2021 [68,70,99–101]. In the "Green Building Creation Scheme" jointly issued by MOHURD and the National Development and Reform Commission, green buildings were officially included in the government's performance assessment indicators, and local governments were required to enhance the financial support and publicity of green buildings [102,103].

Besides policy support, economic incentives were also introduced in China. According to Chang et al. [104], the economic incentives in China include subsidies, awards, and financial innovation. The earliest official green building subsidy in China was implemented in 2006. In 2006, the "Interim Measures for the Management of Special Funds for Renewable Energy Applications in the Construction Industry" was jointly published by the MOF (Ministry of Finance) and MOHURD [104–106]. In 2011, the MOF and MOHURD formulated the subsidy standards for renewable energy and photovoltaic systems in green buildings in China. From the perspective of awards, currency support regulations for green buildings were established by the Chinese central government [13,102,107]. Contractors can obtain monetary rewards according to the star rating and area of their green building projects (45 Yuan/m^2 for Two Star green buildings, 80 Yuan/m^2 for Three Star green buildings) [104]. According to the review by Liu et al. [108], the central government of China allocated 24.4 billion Chinese Yuan (CNY) to green buildings' retrofitting as an economic incentive measure. In terms of financial innovations, the Public–Private Partnership (PPP) was introduced into green building projects. Through Public–Private Partnership promotion, the green-building-related authorities can encourage the government to cooperate with private enterprises and utilize social capital to deliver public green building services in China [36,109–111]. According to the statistics from the International Institute of Green Finance [112], by 2020, the cumulative number of green PPP projects in China had reached 5826, with a 58.1% share of green PPP projects.

From an educational perspective, green buildings are given importance by higher education organizations [113]. In 1996, the report "Population, Environment and Development in China in the 21st Century" was published by the Ministry of Construction in China. This report was deemed the initial development measure for the integration of green building promotion and development and professional education in China [113,114]. Moreover, Niu et al. [115] pointed out that over 300 Chinese universities and colleges have cumulatively developed green-building-related courses or programs since 1997. According to the survey by Gao et al. [116], 67.3% of architecture universities, colleges, or research institutes in China offer green-building-related courses to undergraduate and postgraduate students.

Given the effective contributions in various aspects, the development and promotion of green buildings in China has improved significantly. According to the "China Green Building Market Development Research Report 2020", there were approximately 24.7 thousand national green buildings in China that year. The gross area of green buildings had reached approximately 5.984 billion square meters by 2020. Between 2016 and 2020, there were approximately 3500 new green building projects annually [32,101,117]. By 2018, the proportion of top-rated green buildings in China had reached 14.9% [68].

3.2.3. Green Building Assessment System in China

From the green building assessment systems perspective, there are approximately 70 assessment standards in China [118]. The most popular and essential assessment system is the "Evaluation Standard for Green Buildings (ESGB)", which was developed by the Central Committee of the Communist Party of China (CCCPC). The certification of ESGB is necessary for green buildings in China [89]. In ESGB, evaluation items are categorized as prerequisite items and optional items. The prerequisite items are the requirements that must be achieved, and the optional items are in the form of scores that are used to calculate the total score of the green project [119]. The concept of extra credit was introduced in ESGB 2019. This measure encourages the contractor to further enhance the project's sustainable performance based on meeting the basic standards and adopting innovative tools (e.g., BIM) [120]. There are seven aspects of green buildings that are considered during the assessment: basic requirements; safety and durability (8 prerequisite items and 9 optional items); health and comfort (9 prerequisite items and 11 optional items); occupant convenience (6 prerequisite items and 13 optional items); material conservation and recyclable materials adoption (10 prerequisite items and 18 optional items); environment livability (7 prerequisite items and 9 optional items); promotion and innovation (10 extra credit items) [82,121–123].

In addition to the ESGB, LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) are also adopted as green building evaluation standards [124–127]. By 2021, there were approximately 24,700 green building projects awarded ESGB certification, 2600 projects (over 95.8 million square meters of certificated area) awarded LEED certification, and approximately 120 projects (approximately 11.6 million square meters of certificated area) audited for BREEAM certification in China [91,128]. From 2000 to 2016, LEED-certified green buildings cumulatively reduced energy consumption in China by 69.3 million USD (52.3 million USD in electricity consumption and 8.29 million USD in natural gas utilization [129]).

Compared with the above green building assessment systems, it can be identified that the evaluation criteria of ESGB are more suitable for the national conditions of China [9,26,67,82,118,119,130,131]. In the ESGB, most of the evaluation criteria are result-oriented instead of process-oriented [82]. Most of the indicators focus on the performance, structure, comfort, energy consumption, and material utilization in green buildings [82]. There are very few regulations that address the energy conservation activities, the design, and the construction process of green buildings. For example, LEED states that the distance between the construction site and the material storage point for green buildings should not exceed a certain distance, as materials can be contaminated, wasted, and lost during transportation [125]. However, the ESGB lacks similar provisions [90]. This trend prompted Chinese green building designers and constructors to focus their efforts and resources on improving the performance and comfort of green buildings [126]. Moreover, these abovementioned regulations can prevent Chinese green building construction companies from fraudulently claiming credit in the ESGB through false environmental conservation construction activities to some extent. The rating levels of BREEAM include Pass (30–44 points), Good (45–54 points), Very Good (55–69 points), Excellent (70–84 points), and Outstanding (85 points and above) (BRE, 2021). According to the US Green Building Council (2021), the green building projects that are assessed by LEED are categorized as Certified (40–49 points), Silver (50–59 points), Gold (60–79 points), and Platinum (80 points and above). In China, when a green building project is completed, the green building is required to be assessed according to the ESGB and is awarded One Star (50–59 points), Two Stars (60–79 points), or Three Stars (80 points and above), respectively, according to its overall score [132].

The Chinese ESGB has a different focus and assessment approach compared to mainstream green building assessment systems in other countries. ESGB emphasizes the application of energy efficiency measures, while LEED and BREEAM focus on the assessment of energy efficiency [133]. The above rating systems also include different weights for specific aspects of assessment [134]. In ESGB, the energy category (28%), material conservation and recyclable materials adoption (19%), and indoor environment quality (19%) are defined as the three most important assessment items, which differs from the weighting rankings of LEED (33% in energy category, 17% in location and transportation, 16% in indoor environmental quality) and BREEAM (22% in energy category, indoor environment quality, 14% in management and materials) [83,89,135,136]. In summary, the ESGB was formulated under the natural environmental and social conditions of China [137]. BREEAM was developed to be relatively suitable for Europe. LEED was developed as an assessment system suitable for global dissemination [137].

Comparing ESGB, LEED, and BREEAM, it can be identified that although these green building evaluation systems have different assessment criteria, evaluation items, and weightings, the underlying logic of these evaluation frameworks is identical [138]. Among the assessment criteria, it is observed that they ensure the fulfilment of the basic requirements of green buildings through prerequisites [89]. In addition, the certification degree of the green building is identified based on the score of the optional requirements with different weights [89]. Moreover, additional scores are adopted to motivate green building stakeholders to consider innovative technology adoption.

3.2.4. The Importance of Green Buildings

The energy utilization and gas emissions of the AEC industry have received scholarly attention worldwide. According to the United Nations Environment Program, the energy utilization in the construction industry accounts for approximately 40% of the global total energy consumption, and approximately 30% of greenhouse gas emissions are related to the AEC industry [39]. Meanwhile, AEC activities consume vast amounts of natural resources and generate massive amounts of waste [139]. The China Building Energy Consumption in 2020 Study Report [140–142] stated that the total energy consumption in construction was 2.147 billion TCE (Tons of Standard Coal Equivalent) in 2018, representing 46.5% of the total annual energy consumption in China. The entire building carbon emissions in construction in China totaled 4.93 billion TCo_2, and 51.3% of China's annual carbon dioxide output is due to this factor [140,143–145]. W. Lu et al. [146] revealed that the waste materials produced in the construction and demolition stage of buildings in China in 2014 amounted to approximately 1.13 billion tons.

Green building is pivotal in mitigating the negative impacts of construction activities [147–149]. From the standpoint of reducing greenhouse gas emissions and energy use, green buildings have significant contributions due to their preference for recyclable materials and energy, low-carbon components, and sustainable operation and maintenance patterns [150–153]. Based on the survey by MacNaughton et al. [154], the LEED-certified green buildings cumulatively eliminated 33,200 kilotons of CO_2 emissions, 91.12 kilotons of air pollutants, and 55.56 billion kW.h of electricity consumption from 2000 to 2016. Between 2000 and 2016, the health advantages of LEED-certified green buildings in the USA assisted in eliminating approximately 172–405 premature deaths, 171 cases of hospitalization, 11,000 asthma flare-ups, 54,000 cases of respiratory damage, 21,000 cases of unemployment, and 16,000 school losses [129]. Compared with regular construction, Dwaikat and Ali [155] found that the reduction in energy consumption in investigated green buildings was approximately 71.1%, and the energy conservation was approximately 5756 kWh/m^2 in the lifecycle of construction. In the case study of Balaban and Puppim de Oliveira [156], the decrease in energy utilization intensity in the selected green building projects was, respectively, 33% and 26%. Besides this, the chosen projects decreased their CO_2 emissions intensity by 38% and 32% compared to benchmark values. In comparison to conventional construction, Eisenstein et al. [157] revealed that LEED-certified green buildings could produce 50% less greenhouse gases (GHG) owing to water usage and 48% less GHGs related to solid waste optimization. If LEED standards could be utilized in an entire California office building stock, the potential gross decline in GHG emissions would amount to approximately 862,920 $MgCO_2e/year$ [29,158,159].

Green buildings can provide adequate support for expenditure conservation and value improvement. According to Chen et al. [160], Kim et al. [161], and Liu et al. [162], the economic benefits of green buildings can be considered through following approaches:

1. Through mitigating energy consumption, construction waste generation, sanitation expenditure, and devices' operation and maintenance disbursement to reduce green building expenditure during their construction, operation, maintenance, and refurbishment stages;

2. Through the incremental benefits that are created by green-building-related applications and advanced technologies (they are generally more expensive than conventional buildings to achieve the same quality);
3. Through the combined cost-effectiveness of green buildings throughout their lifecycles.

Between 2000 and 2016, the energy expenditure worldwide decreased by approximately 7.5 billion dollars with the assistance of LEED-certified green buildings, which also brought an estimated 5.8 billion dollars of co-benefits in climate and health to the USA, Brazil, China, Germany, India, and Turkey [129]. Balaban and Puppim de Oliveira [156] announced that the average annual economic benefit generated by selected green buildings in Japan was 116 million Yen, equivalent to approximately 1000 Yen per square meter. In addition to reducing operational expenditures, green buildings have remarkable benefits in boosting price premiums, rent premiums, and Willingness-To-Pay (WTO) [163]. The Sustainable Energy Authority of Ireland [164] stated that upgrading green buildings in Ireland from F-Level to B1-Level can result in a price premium of EUR 1617 or a rent premium of EUR 1119. L. Zhang et al. [165] calculated that the green building premium is approximately 6.9% in China. The premium for green buildings in the Netherlands ranged from 1.1% to 6.5% [166]. According to interviews among occupants and residents, the WTP for green buildings in China, Singapore, and Switzerland was, respectively, 2.1–22.9%, 3.8–8.0%, and 3.0–5.0% [167–169].

Green buildings have significant contributions to the improvement of residents' comfort and health, users' experiences, and efficiency [151]. From the viewpoint of health and occupants' comfort, green buildings can effectively reduce the exposure of occupants to harmful materials and toxic gases [170,171]. Moreover, given the favorable natural ventilation and light in green buildings, they can provide the appropriate thermal comfort for occupants [156,172]. Besides this, the health protection and purification approaches adopted in green buildings can beneficially eliminate water contamination and reduce the spread of harmful bacteria inside the building [156]. Moreover, the psychologically appropriate interior plan and green plants' placement optimization in partially green buildings can improve the occupants' psychological condition [173–175].

According to the social experiments by Buonocore et al. [176] and Cedeño-Laurent et al. [177], there was less negative feedback and symptom reports from green buildings' occupants compared to traditional constructions. Among the participants in the green building group, there was a 91% reduction in feedback about insufficient airflow, a 28% reduction in feedback about unpleasant smells, and a 63% reduction in feedback about dryness compared to the participants who were residents of regular buildings. Furthermore, green buildings can assist individuals by providing a 65%, 28%, 67%, 70%, and 50% reduction in sensory, cognitive, respiratory, eye and skin, and viral symptoms, respectively [154]. Holmgren et al. [178] highlighted that the advantages of green buildings are increased workplace satisfaction and the ability to induce a more positive perception of certain aspects of the interior environment. The suitable carbon dioxide concentration and total volatile organic compound concentration in green buildings sustain the occupants' favorable user experience and working efficiency [179]. Allen et al. [180] stated that the Basic Activity Level and Focused Activity Level of employees could be improved, respectively, by 35–37% and 44–52% when they work in green buildings (total volatile organic compounds under 450 $\mu g/m^3$). Respondents in LEED buildings assessed their job performance as 114% higher than employees who performed similar jobs [181,182]. Dreyer et al. [183] concluded, in their questionnaire survey, that green buildings can effectively enhance the hedonism and eudaimonia of participants and mitigate their negative wellbeing. Low-carbon green buildings can obtain more satisfactory evaluations than conventional buildings [178]. According to the data analysis of green buildings in the Middle East by Elnaklah et al. [182], 85% of TSVs (Tab-Separated Values) in selected green buildings fell within the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) acceptable comfort zone criteria, being better than conventional buildings, which demonstrated that selected green buildings have better thermal comfort. In a survey about sustainable retrofitting in the university canteen buildings of Shandong Jianzhu University, the satisfaction with the spatial shape, interior layout, and dining experience improved by 38%, 39%, and 67% after the sustainable retrofitting was conducted [184].

3.2.5. The Barriers to Green Building Development in China

From a technological standpoint, green buildings require innovative technologies in their design, construction, operation, and maintenance [156,185,186]. Given the environmental benignity, energy conservation, low greenhouse gas emissions, and absence of toxic materials in green buildings, stakeholders prefer to adopt multiple advanced technologies to meet the evaluation criteria for green buildings, including building information modeling, digital twin, smart building, RFID (Radio Frequency Identification Devices), and so on [11,37,68]. In the technology aspect, the inconsistency of software standards in different technologies utilized in green buildings' lifecycles is the most significant barrier [187–190]. In the process of BIM and digital twin implementation in green buildings, the IFC (Industry Foundation Class) and gbXML are adopted as the data organization formats [191–193]. Moreover, the IFD (International Framework for Dictionaries) is utilized to determine the designations and definitions of the various objects and components in the BIM and digital twin model [194,195]. Moreover, IDM is performed to deliver the demand for corresponding data in the entire processes [187,188]. In the integration of smart cities with green buildings, the CityGML (Geography Markup Language) is the most common data organization format to be applied [196–198]. However, the abovementioned standards and formats are difficult to interface directly with traditional 2D drawings and the conventional design and construction management software due to the mismatched formats [199]. Furthermore, green buildings commonly require multiple third-party devices to collaborate with each other in their operation and maintenance process, but the deficiencies of common data standards lead to their insufficient compatibility in green buildings' facility management processes [200].

According to Huang et al. [27], over 85% (175/205) of respondents believed that the mismatched standards led to inefficiencies and errors in multi-technology cooperation. Moreover, the insufficient compatibility of these advanced technologies is deemed a severe barrier to the collaboration and communication between stakeholders in different organizations [37,201–203].

Besides the above, inadequate training regarding these advanced technologies for design and construction personnel is a significant obstacle to the development and promotion of green buildings in China [11,204–207]. In the process of BIM and digital twin utilization in green buildings, many stakeholders can work on the same platform or software. Their outputs can be integrated into one single file. This issue leads to the blurring of intellectual property rights [208–210]. Given that the stakeholders are collaborating on the same platform and files, the boundaries between contributions from different stakeholders are challenging to define [209,211–215]. Moreover, this obstacle can cause conflicts of interest and intellectual property ownership between stakeholders [208–210,214]. Moreover, a report from the Shanghai Municipal Commission of Housing Urban-Rural Development and Management highlighted that the development of green buildings in China is hampered by the uncertain functional positioning of building energy conservation technology systems and operational energy efficiency constraints in public buildings [12,108,216,217].

From the financial standpoint, the high cost of green buildings has been a critical problem for green-building-related stakeholders in China [80,155,218,219]. Dwaikat and Ali [220] pointed out that the cost premium in the green buildings investigated in their study could reach 21%. According to the survey by Taemthong and Chaisaard [221], the cost premiums of green buildings awarded gold and platinum certification are slightly higher than conventional buildings' costs at 2.15% and 8.92%, respectively. Although green buildings have a lower expenditure for energy consumption during their operation and maintenance processes compared to conventional buildings, the high initial cost causes hesitation among clients and contractors regarding green buildings [23,27,80,222].

Furthermore, according to the summary by Ding et al. [89], it is difficult for contractors to balance income and expenditure in partial green building projects in China. Although there are economic incentive measures and cost savings in operation and maintenance, high upfront costs lead to the hesitation of contractors in green building projects. According to the review by Darko and Chan [38], green buildings have higher expenditures than regular (non-green) structures in their construction processes. The additional expenditures include the increased purchasing costs, green-building-related device installation charges (such as geothermal heat pumps and solar equipment), installation fees, and higher labor costs. Besides these, China lacks a mature green building market mechanism, and the transparency of the green building market needs to be improved [89]. The abovementioned phenomenon leads to a long payback period and inferior Return of Investment (ROI) for green building projects in China. Due to the high price sensitivity of clients, clients prefer to adopt low-expenditure design-build solutions or conventional construction materials and equipment from local contractors, instead of green-building-related devices or technologies [218,222].

From the perspective of regulations, given the absence of the effective monitoring of the construction and operation of green buildings by the authorities, partially certified green buildings cannot fulfil the criteria of the "Evaluation standard of Green Building in China (2018)" [95,216]. Moreover, Chang et al. [104] point out that a gap still exists between macro-control by the central government and policy implementation by local governments; in addition, the concept of green buildings is not popularized among the Chinese public. In the operation and maintenance stage of green buildings in China, the supervision and monitoring mechanism is deficient, which causes a decline in the quality of the operation and maintenance phase [13,107,135].

Moreover, given the differences in policies and regulations related to green buildings in different provinces in China, regulatory barriers can add to the difficulty of green building design and construction organization in cross-provincial green building projects [70,216,222]. Moreover, the lack of awareness is also a critical hindrance to green building development in China [223]. Although the AEC industry personnel in China are familiar with green buildings, the public in China is relatively unfamiliar with these sustainable buildings [27].

4. Discussion

Based on the research results that presented in Section 3, the authors reviewed the definition evolution, development trends, and evaluation standards of green buildings in China. Moreover, the contributions and barriers to green building promotion are revealed in Section 3. These results are important in developing and promoting green buildings in China. The definition and development trends of green buildings reviewed in this study can assist the AEC personnel in enriching their green-building-related knowledge in China to enhance green building promotion. Moreover, the abovementioned research results can increase the public's familiarity with green buildings and thus increase the public's acceptance of green buildings. Furthermore, the researchers summarize the evaluation criteria and incentive policies for green buildings in China in Sections 3.2.2 and 3.2.3. Based on these research results, green building practitioners can monitor the compliance of their green building projects with the evaluation standards throughout the lifecycle and secure appropriate financial incentives and policy support for their projects. In Section 3.2.3, the authors compare ESGB with LEED and BREEAM, reveal the characteristics and shortcomings of ESGB, and provide corresponding optimization recommendations for it. Moreover, the green building regulatory authorities in China can optimize the ESGB in line with the above advice. In Sections 3.2.4 and 3.2.5, the benefits and obstacles of green building development are reviewed. This information can enable green-building-related personnel to design their green buildings in the targeted methods to carry forward better contributions and minimize the defects of green buildings. In Section 3.2.5, the barriers and recommendations for third-party devices (including building information modeling, digital twin, RFID, smart buildings, GIS, and remote sensing) utilized in green buildings are considered, which can promote the integration of green buildings and external plugins and equipment to optimize their quality and cost performance.

In addition to green buildings, there are multiple systematic reviews of other architectural types. Lv and Zhang [224] and Navaratnam et al. [225] developed systematic reviews of prefabricated buildings' development and optimization. Moreover, systematic reviews of high-rise residential buildings were also performed by Barros et al. [226] and Kalantari et al. [227]. Based on the research results in the abovementioned reviews, it can be identified that green buildings have significant environmental and ecological improvement benefits compared to high-rise buildings and assembled buildings. In addition, green buildings offer a more comfortable living experience. However, given the insistence on environmentally friendly materials, energy-efficient technologies, and occupants' comfort, green buildings generally have higher expenditures than the equivalent high-rise buildings and assembled buildings over their lifecycles. Another contrast between green buildings, high-rise residential buildings, and prefabricated buildings is that the green buildings are required to meet corresponding regulations and accept supervision from governments during their entire operation and maintenance phase due to the strict requirements of ESGB.

After the article selection and review were accomplished, the results of the section were carried into the next stage to conduct the discussions and analysis. Through the discussion and classification in Section 4, the overview of green buildings' history and the development trends in China are summarized. Moreover, the benefits, challenges, and future directions of green building development in China are discussed in this section.

4.1. An Overview of Green Building Development in China

A green building is a high-quality building that can conserve resources, protect the environment, minimize pollution, and provide occupants with a healthy, suitable, and efficient living environment, maximizing the benign coexistence of human beings and nature during the entire lifecycle of green buildings [9–11,50,67,69–74,76,78,82,83,85,87]. The earliest official concepts of the modern green building date back to the 1960s [53–55]. In 1987, due to the "Our Common Future" report developed by United Nations Environment Program, the official contemporary sustainable building standards were determined [59–62]. Since the 1990s, green buildings have been gradually introduced into the USA, Britain, Australia, Singapore, Canada, and Japan [56,63–68]. In China, the origin of modern green buildings can be traced to the 1980s, with the drafting of the "Energy-Saving Design Standards for Civil Buildings" [13,70,113]. In 2006, the green building was officially introduced in China with the publication of the "Evaluation Standard of Green Buildings (First Version)" [13,70,86,97–101].

To enhance Chinese green building promotion and development, green building assessment systems specific to green buildings in China have been developed [70,89,118,119]. There are various green building assessments worldwide, including LEED (USA), BREEAM (UK), CASBEE (Japan), and Green Mark (Singapore) [201,228–234]. Based on the abovementioned green building evaluation frameworks, the Evaluation Standard of Green Buildings (ESGB) was developed by the Chinese government [67,119,130]. Compared with the green building evaluation frameworks in other countries, the ESGB is more suitable for green buildings in China [9,26,67,82,118,119,130,131,137]. From the perspective of indicators' weightings, ESGB is relatively focused on energy efficiency measures' utilization [83,89,135,136,235]. Based on the situation of the AEC industry in China, there are seven evaluation aspects of green buildings included in ESGB, including basic requirements; safety and durability; health and comfort; occupant convenience; material savings and material resource utilization; environment livability; promotion and innovation [9,26,67,119,131,137,235]. In the process of green building evaluation, the assessed green buildings are given a corresponding score based on the extent to which each evaluation item is achieved. Once the scoring procedure is accomplished, the green buildings are awarded different levels of certification (One Star, Two Stars, or Three Stars) based on their scores [95,97,102,135,216,235].

4.2. The Benefits and Challenges of Green Building Development in China

Through the discussion and analysis of the research results that are described in Section 3, it can be determined that green buildings can provide significant benefits throughout China. In the aspect of environmental preservation, green buildings can effectively achieve energy conservation and greenhouse gas reduction in China [140,143–145,147–153]. Through green building development, the negative environmental impact and energy consumption that are caused by construction activities in China can be effectively mitigated. With the promotion and development of green buildings in China, the production of carbon dioxide, air pollutants, toxic gases, and solid waste has been obviously reduced further to optimize the health status of Chinese residents [29,155–159].

Furthermore, the economic benefits of green buildings in China are also significant. Given the reductions in toxic waste production and greenhouse gas emissions that are achieved by green buildings, the expenditure that is utilized in environmental protection has seen a noticeable reduction in China, the USA, Brazil, the UK, Germany, Japan, India, and Turkey [129,154,156,163]. Due to the energy conservation characteristic of sustainable buildings, the energy expenditure has been effectively reduced in their operation and maintenance processes [25,165–169,201,203,218,236]. Moreover, green buildings also bring remarkable benefits for residents' comfort and health. Green buildings effectively reduce occupant discomfort and morbidity and increase occupant satisfaction to improve the users' experience further, as well as the work efficiency of green building occupants in China [129,151,154,158,176–178,180,182–184,237–240].

Given the abovementioned benefits, to encourage the construction of green buildings in China, the Chinese government and the AEC sector have taken multiple measures. To promote green building development in China, incentive measures are put forward from policy, finance, and education perspectives [36,39,102,111]. From the standpoint of policy, multiple development planning regulations have been developed by the government since 2011 [64–66,102,103]. The central government in China has instructed the local authorities to increase the number of green buildings and the green building material utilization rate through administrative orders [56,64–68]. Moreover, the progress of green building development is integrated into the annual examination of the corresponding officers and civil servants [102,103]. From the perspective of finance and investment, both central and local governments in China have proposed considerable appropriations for green building development [34,70,102,107,216]. The government allocated significant funds for the construction of green public buildings with public ownership and subsidized green-building-related organizations according to their contributions [13,102,104–108,163].

Moreover, private contractors are encouraged to invest in public green buildings through the Public–Private Partnership (PPP) [36,109–112]. From the educational perspective, over 60% of higher education organizations in the AEC field have been required to develop sustainable construction courses and programs to train green-building-related personnel [110,113–115]. Due to the abovementioned incentive measures, the area of green buildings in China reached approximately 6 billion square meters in 2020 [32,68,101,117].

Despite the tremendous measures adopted to promote green building development in China, some challenges still need to be overcome in this field. From the perspective of technical obstacles, incompatible file formats and mismatched technical standards are the most severe obstacles to green building development [11,27,37,68,156,185–190,201–203]. Moreover, insufficient training regarding green-building-related technologies among green building design and construction personnel also delays the development and promotion of green buildings in China [11,204–207]. In addition, due to the ambiguous property rights boundaries of the outcomes in the green building design and construction process, the working willingness of green building designers in China can be negatively affected [12,108,208–217].

Moreover, the financial and regulatory barriers to green building development in China are also non-negligible. From the financial perspective, the high initial expenditure, excessive cost premiums, and long payback period lead to the hesitation of contractors to adopt green buildings [27,38,80,89,155,202,218,219,221,222]. In the regulatory aspect, the deficiencies of government regulatory and different green-building-related local policies are obstacles to green buildings' improvement in China. Moreover, the inadequate public awareness of green buildings is also a significant impediment to the improvement of green buildings [13,95,97,104,107,135,216].

4.3. The Future Directions of Green Building Development in China

Through the above discussion and analysis of the advantages and disadvantages of green building development in Section 4.2, it can be identified that government regulations and policy improvements are critical future directions in green building development. The suitable and constant regulation and legislation from governments can be deemed the most effective top-down and external drivers for green-building-related enterprises to mitigate the negative risks associated with future regulatory and law changes [241–244]. Arif et al. [245] also suggested that regulation and supervision by the official authorities are the most effective methods to encourage AEC organizations to embrace green buildings. According to Khoshnava et al. [246], 58.3% of respondents believed that legislation and policies are the most critical drivers of green building development.

From the perspective of governments, the future directions for green buildings developed in China were developed. Qian et al. [247] stated that the government should issue mandatory regulations on the quantity and percentage of green buildings in new constructions in China to ensure their development. Moreover, given the inconsistent policy frameworks to integrate the various aspects of green building requirements in China, it is necessary for the government to introduce an integrated policy to address this issue [104,248]. Furthermore, in the policy formulation process, the developers of green building policies should take the advantages of green buildings for the economy and society into consideration [104]. Given the inadequate transparency in the regulation process of green buildings in China, it is essential to establish an independent regulatory authority to supervise green building projects in China [135,249,250].

From the aspect of the green building assessment framework, the Evaluation Standards of Green Buildings (ESGB) in China must be revised to address the problems regarding the deficiencies or imperfect requirements of green buildings [135,250]. In addition, the openness and fairness of the green building assessment and certification process should be enhanced [19,135,251]. Darko et al. [252] suggested that inviting third-party independent assessment organizations to replace the government departments for green component certification is a viable measure. Moreover, clear and specific evaluation criteria should be added to the qualitative analysis items in ESGB to address the vague criteria of these qualitative analysis items [67,89,222]. Considering the distinct natural environment and economic development of the provinces of China, it would be indispensable to develop region-specific green building assessment criteria [250,253,254].

From the angle of green-building-related technologies, several suggestions for the future development of green buildings in China are developed. It is believed that the green-building-related technologies should be formulated to possess interoperability, as their outputs are better when they are in the same format [19,27,187,255–257]. Besides this, increased government funding and subsidies for green buildings are feasible methods to promote green building development in China. By compensating stakeholders for the additional expenditure in the construction and promotion of green buildings in China, a financial incentive can assist the stakeholders in mitigating their hesitation toward green buildings [13,39,241]. For public awareness, it is vital to propagandize the benefits and advantages of green buildings to the public. Liu et al. [258] specified that the clients' requirements, social trust, and environmental attitudes are the principal factors influencing the willingness to make green building purchases, and these factors can be influenced by publicity. Moreover, the publicity of green buildings can have positive effects on the marketing benefits of green building projects [107,222,241,258]. This could encourage the AEC organization to undertake more green building projects to improve their corporate reputations [241,258].

5. Conclusions

Given the severe pollution caused by traditional constructions, they have an extremely negative impact on environmental conservation and sustainable development. Against the abovementioned background, green building is becoming a prominent trend worldwide. Despite the increasing emphasis on green buildings worldwide, the development of green buildings in China remains in its initial phase. A major impediment to the promotion of green buildings is the lack of a comprehensive understanding of green building development's status in China. To enhance AEC personnel's familiarity with green buildings in China and to promote the development of green buildings in China, this study sought to conduct a comprehensive systematic literature review of green building development in China. In this study, 186 articles were selected and subjected to a full content review. Through the systematic review, the definition, development trends, evaluation standards, importance, and hindrances of green buildings in China were reviewed.

Based on the articles screened and reviewed in Section 3, the advantages and challenges of green building development in China were discussed and analyzed in Section 4. Through the discussion and analysis, it can be determined that the prospects and potential for green building development in China are incredibly significant, despite some barriers in the development process. Moreover, the abovementioned discussions and analysis considered the future directions and suggestions for green buildings in China from the viewpoints of governments, assessment frameworks, technologies, finance, and public awareness.

This systematic review can enhance the familiarity of individuals with the green building development situation, to provide knowledge support for green building improvement and promotion in China. Moreover, the future direction that is developed in this study can provide guidance for the affiliated organizations (such as the government, green-building-related enterprises, green building assessment framework developers, etc.) regarding green building development in China. Through the above contributions, this study can effectively enhance environmental protection, sustainable development, and public health in China. For countries that are in line with China's national conditions (such as Vietnam), the research results in this study can be applied to some extent [222].

Besides the abovementioned contributions, there are still several limitations in this study:

To accomplish an exhaustive systematic review, some articles focused on green building development in other, developed countries are included in this study. This method reduces the relevance of the work to a certain extent. However, these articles were included in this study to achieve a comprehensive review of green building development-related knowledge in China and provide arguments and support for partial viewpoints.

Due to the authors' language skills, only English articles were reviewed. Non-English articles were not included in this study.

Given the schedule limitations, articles published after May 2022 could not be included in this study. This limitation might have led to the omission of some Chinese green-building-related achievements.

To overcome the abovementioned limitations, other researchers are encouraged to perform corresponding studies to deal with these issues. Based on this study, other researchers can conduct systematic reviews of green-building-related development in China that include both English articles and non-English articles in their studies. Moreover, other researchers can utilize the research results in this study to explore the development status of green buildings worldwide.

Author Contributions: Y.C. wrote the original draft and conducted data curation and formal analysis; Y.C., N.M.A., C.X. and S.N.K. were responsible for the review and conceptualization; C.X., N.M.A. and S.N.K. were responsible for the supervision. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable. Readers can contact Yu Cao (s2035978@siswa.um.edu.my) if they have any questions you would like to ask.

Acknowledgments: First, we express our gratitude to Nur Mardhiyah Aziz and Syahrul Nizam Kamaruzzaman. Their insightful advice and helpful comments inspired us to improve our thinking and raised the caliber of our work. We would also like to thank Mingru Cao, Yan Zhang, and Yuehua Ma. Their helpful advice and kind support motivated us to complete this research.

Conflicts of Interest: The authors declare that they have no conflict of interest in this study.

References

1. Hamilton, I.; Rapf, O. *2021 Global Status Report for Buildings and Constructions*; Global Alliance for Buildings and Constructions: Paris, France, 2021.
2. Cheriyan, D.; Choi, J. A Review of Research on Particulate Matter Pollution in the Construction Industry. *J. Clean. Prod.* **2020**, *254*, 120077. [CrossRef]
3. Wieser, A.A.; Scherz, M.; Passer, A.; Kreiner, H. Challenges of a Healthy Built Environment: Air Pollution in Construction Industry. *Sustainability* **2021**, *13*, 10469. [CrossRef]
4. Yang, S.; Liu, J.; Bi, X.; Ning, Y.; Qiao, S.; Yu, Q.; Zhang, J. Risks Related to Heavy Metal Pollution in Urban Construction Dust Fall of Fast-Developing Chinese Cities. *Ecotoxicol. Environ. Saf.* **2020**, *197*, 110628. [CrossRef] [PubMed]
5. *2021 Bulletin on the State of China's Ecological Environment*; Ministry of Environmental Protection of the People's Republic of China: Beijing, China, 2022.
6. Wu, Z.; Zhang, X.; Wu, M. Mitigating Construction Dust Pollution: State of the Art and the Way Forward. *J. Clean. Prod.* **2016**, *112*, 1658–1666. [CrossRef]
7. *Public Health Social and Environmental Determinants of Health Department Burden of Disease from the Joint Effects of Household and Ambient Air Pollution for 2016*; World Health Organization: Geneva, Switzerland, 2018.
8. *World Health Statistics 2020: Monitoring Health for the SDGs, Sustainable Development Goals*; World Health Organization: Geneva, Switzerland, 2020.
9. Ministry of Housing and Urban-Rural Development. *Evaluation Standard for Green Building*; Ministry of Housing and Urban-Rural Development: Beijing, China, 2018.
10. Cao, Y.; Kamaruzzaman, S.; Aziz, N. Green Building Construction: A Systematic Review of BIM Utilization. *Buildings* **2022**, *12*, 1205. [CrossRef]
11. Lu, Y.; Wu, Z.; Chang, R.; Li, Y. Building Information Modeling (BIM) for Green Buildings: A Critical Review and Future Directions. *Autom. Constr.* **2017**, *83*, 134–148. [CrossRef]
12. Shanghai Municipal Commission of Housing Urban-Rural Development and Management. *Shanghai Green Building Development Report (2019)*; Shanghai Municipal Commission of Housing Urban-Rural Development and Management: Shanghai, China, 2020.
13. Zhang, L.; Wu, J.; Liu, H. Policies to Enhance the Drivers of Green Housing Development in China. *Energy Policy* **2018**, *121*, 225–235. [CrossRef]
14. Wu, Z.; Jiang, M.; Cai, Y.; Wang, H.; Li, S. What Hinders the Development of Green Building? An Investigation of China. *Int. J. Environ. Res. Public Health* **2019**, *16*, 3140. [CrossRef]
15. Liu, X.; Hu, W. Attention and Sentiment of Chinese Public toward Green Buildings Based on Sina Weibo. *Sustain. Cities Soc.* **2019**, *44*, 550–558. [CrossRef]
16. Yin, S.; Li, B.; Xing, Z. The Governance Mechanism of the Building Material Industry (BMI) in Transformation to Green BMI: The Perspective of Green Building. *Sci. Total Environ.* **2019**, *677*, 19–33. [CrossRef]
17. Huo, X.; Yu, A.T.W.; Darko, A.; Wu, Z. Critical Factors in Site Planning and Design of Green Buildings: A Case of China. *J. Clean. Prod.* **2019**, *222*, 685–694. [CrossRef]
18. Olanipekun, A.O.; Chan, A.P.C.; Xia, B.; Adedokun, O.A. Applying the Self-Determination Theory (SDT) to Explain the Levels of Motivation for Adopting Green Building. *Int. J. Constr. Manag.* **2018**, *18*, 120–131. [CrossRef]
19. Chan, A.P.C.; Darko, A.; Olanipekun, A.O.; Ameyaw, E.E. Critical Barriers to Green Building Technologies Adoption in Developing Countries: The Case of Ghana. *J. Clean. Prod.* **2018**, *172*, 1067–1079. [CrossRef]
20. Kasai, N.; Jabbour, C.J.C. Barriers to Green Buildings at Two Brazilian Engineering Schools. *Int. J. Sustain. Built Environ.* **2014**, *3*, 87–95. [CrossRef]

21. Shen, W.; Tang, W.; Siripanan, A.; Lei, Z.; Duffield, C.; Hui, F. Understanding the Green Technical Capabilities and Barriers to Green Buildings in Developing Countries: A Case Study of Thailand. *Sustainability* **2018**, *10*, 3585. [CrossRef]
22. Chan, A.P.C.; Darko, A.; Ameyaw, E.E.; Owusu-Manu, D.-G. Barriers Affecting the Adoption of Green Building Technologies. *J. Manage. Eng.* **2017**, *33*, 4016057. [CrossRef]
23. Hwang, B.-G.; Tan, J.S. Green Building Project Management: Obstacles and Solutions for Sustainable Development: Green Building Project Management: Obstacles and Solutions for Sustainable Development. *Sust. Dev.* **2012**, *20*, 335–349. [CrossRef]
24. Samari, M.; Ghodrati, N.; Esmaeilifar, R.; Olfat, P.; Shafiei, M.W.M. The Investigation of the Barriers in Developing Green Building in Malaysia. *Mod. Appl. Sci.* **2013**, *7*, 1–10. [CrossRef]
25. Mesthrige, J.W.; Kwong, H.Y. Criteria and Barriers for the Application of Green Building Features in Hong Kong. *Smart Sustain. Built Environ.* **2018**, *7*, 251–276. [CrossRef]
26. Guo, K.; Li, Q.; Zhang, L.; Wu, X. BIM-Based Green Building Evaluation and Optimization: A Case Study. *J. Clean. Prod.* **2021**, *320*, 128824. [CrossRef]
27. Huang, B.; Lei, J.; Ren, F.; Chen, Y.; Zhao, Q.; Li, S.; Lin, Y. Contribution and Obstacle Analysis of Applying BIM in Promoting Green Buildings. *J. Clean. Prod.* **2021**, *278*, 123946. [CrossRef]
28. Na, Z.; Bin, Y.; Zhixuan, Z.; Meijie, W. Application of BIM in Green Building Materials Management. *J. Phys. Conf. Ser.* **2021**, *1986*, 12024. [CrossRef]
29. Wang, J.; Zhang, Y.; Wang, Y. Comparison of Both Old and New Versions of the Evaluation Standard for Green Building in China with LEED in American. In *Low-Carbon City and New-Type Urbanization*; Feng, S., Huang, W., Wang, J., Wang, M., Zha, J., Eds.; Environmental Science and Engineering; Springer: Berlin/Heidelberg, Germany, 2015; pp. 89–99. ISBN 978-3-662-45968-3.
30. Wang, Y. Analysis on the Development of Green Building in China . In Proceedings of the International conference on Future Energy, Environment and Materials, Paris, France, 27–28 October 2014; pp. 541–548.
31. Yang, H.-C.; Shiau, Y.-C.; Lo, Y.-H. Development of a BIM Green Building Evaluation Software. In Proceedings of the 2017 International Conference on Applied System Innovation (ICASI), IEEE. Sapporo, Japan, 13–17 May 2017; pp. 231–234.
32. Yi-hong, W.; Xiao-nan, L. Research on the Development and Technology Selection of Green Building in China. *E3S Web Conf.* **2021**, *248*, 3027. [CrossRef]
33. Zhao, H.; Li, X.; Qi, Y. Research on the Application of BIM Technology in the Design of Green Buildings. In Proceedings of the 2021 International Conference on E-Commerce and E-Management (ICECEM), IEEE. Dalian, China, 24–26 September 2021; pp. 94–98.
34. Zou, Y.; Zhao, W.; Zhong, R. The Spatial Distribution of Green Buildings in China: Regional Imbalance, Economic Fundamentals, and Policy Incentives. *Appl. Geogr.* **2017**, *88*, 38–47. [CrossRef]
35. Mulrow, C.D. Systematic Reviews: Rationale for Systematic Reviews. *BMJ* **1994**, *309*, 597–599. [CrossRef]
36. Akomea-Frimpong, I.; Kukah, A.S.; Jin, X.; Osei-Kyei, R.; Pariafsai, F. Green Finance for Green Buildings: A Systematic Review and Conceptual Foundation. *J. Clean. Prod.* **2022**, *356*, 131869. [CrossRef]
37. Chen, L.; Chan, A.P.C.; Owusu, E.K.; Darko, A.; Gao, X. Critical Success Factors for Green Building Promotion: A Systematic Review and Meta-Analysis. *Build. Environ.* **2022**, *207*, 108452. [CrossRef]
38. Darko, A.; Chan, A.P. Review of Barriers to Green Building Adoption. *Sustain. Dev.* **2017**, *25*, 167–179. [CrossRef]
39. Olubunmi, O.A.; Xia, P.B.; Skitmore, M. Green Building Incentives: A Review. *Renew. Sustain. Energy Rev.* **2016**, *59*, 1611–1621. [CrossRef]
40. Xiao, Y.; Watson, M. Guidance on Conducting a Systematic Literature Review. *J. Plan. Educ. Res.* **2019**, *39*, 93–112. [CrossRef]
41. Harris, J.D.; Quatman, C.E.; Manring, M.M.; Siston, R.A.; Flanigan, D.C. How to Write a Systematic Review. *Am. J. Sport. Med.* **2014**, *42*, 2761–2768. [CrossRef] [PubMed]
42. Jesson, J.; Matheson, L.; Lacey, F.M. *Doing Your Literature Review: Traditional and Systematic Techniques*; SAGE: London, UK, 2011.
43. Munn, Z.; Peters, M.D.; Stern, C.; Tufanaru, C.; McArthur, A.; Aromataris, E. Systematic Review or Scoping Review? Guidance for Authors When Choosing between a Systematic or Scoping Review Approach. *BMC Med. Res. Methodol.* **2018**, *18*, 143. [CrossRef] [PubMed]
44. Pittaway, L.; Robertson, M.; Munir, K.; Denyer, D.; Neely, A. Networking and Innovation: A Systematic Review of the Evidence: Networking and Innovation: A Systematic Review of the Evidence. *Int. J. Manag. Rev.* **2004**, *5–6*, 137–168. [CrossRef]
45. Pittaway, L.; Cope, J. Entrepreneurship Education: A Systematic Review of the Evidence. *Int. Small Bus. J.* **2007**, *25*, 479–510. [CrossRef]
46. Aromataris, E.; Pearson, A. The Systematic Review: An Overview. *Am. J. Nurs.* **2014**, *114*, 53–58. [CrossRef] [PubMed]
47. Munn, Z.; Stern, C.; Aromataris, E.; Lockwood, C.; Jordan, Z. What Kind of Systematic Review Should I Conduct? A Proposed Typology and Guidance for Systematic Reviewers in the Medical and Health Sciences. *BMC Med. Res. Methodol.* **2018**, *18*, 5. [CrossRef]
48. Pearson, A. Balancing the Evidence: Incorporating the Synthesis of Qualitative Data into Systematic Reviews. *JBI Rep.* **2004**, *2*, 45–64. [CrossRef]
49. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews. *Syst. Rev.* **2021**, *10*, 89. [CrossRef]

50. Cao, Y.; Kamaruzzaman, S.N.; Aziz, N.M. Building Information Modeling (BIM) Capabilities in the Operation and Maintenance Phase of Green Buildings: A Systematic Review. *Buildings* **2022**, *12*, 830. [CrossRef]
51. Regona, M.; Yigitcanlar, T.; Xia, B.; Li, R.Y.M. Opportunities and Adoption Challenges of AI in the Construction Industry: A PRISMA Review. *J. Open Innov. Technol. Mark. Complex.* **2022**, *8*, 45. [CrossRef]
52. Yigitcanlar, T.; Desouza, K.C.; Butler, L.; Roozkhosh, F. Contributions and Risks of Artificial Intelligence (AI) in Building Smarter Cities: Insights from a Systematic Review of the Literature. *Energies* **2020**, *13*, 1473. [CrossRef]
53. Evans, B. From the Past to the Future: Towards a New Paradigm in Landscape and Environment. 2017. Available online: http://radar.gsa.ac.uk/5922/ (accessed on 7 August 2022).
54. Evans, B.M. *Ian Lennox McHarg, Scotland and the Emergence of Green Consciousness*; Lincoln Institute of Land Policy: Cambridge, MA, USA, 2019.
55. McHarg, I.L. *The Essential Ian McHarg: Writings on Design and Nature*; Island Press: Washington, DC, USA, 2006.
56. Kibert, C.J. Green Buildings: An Overview of Progress. *Fla. State Univ. J. Land Use Environ. Law* **2018**, *19*, 11.
57. United States Environmental Protection Agency Green Building History in the U.S. Available online: https://archive.epa.gov/greenbuilding/web/html/about.html (accessed on 7 August 2022).
58. Li, Y.; Yang, L.; He, B.; Zhao, D. Green Building in China: Needs Great Promotion. *Sustain. Cities Soc.* **2014**, *11*, 1–6. [CrossRef]
59. Brundtland, G.H. Our Common Future—Call for Action. *Environ. Conserv.* **1987**, *14*, 291–294. [CrossRef]
60. Imperatives, S. Report of the World Commission on Environment and Development: Our Common Future. *Accessed Feb* **1987**, *10*, 1–300.
61. Keeble, B.R. The Brundtland Report: 'Our Common Future'. *Med. War* **1988**, *4*, 17–25. [CrossRef]
62. Holden, E.; Linnerud, K.; Banister, D. Sustainable Development: Our Common Future Revisited. *Glob. Environ. Change* **2014**, *26*, 130–139. [CrossRef]
63. AIA; EPA. *Environmental Resource Guide and Energy Star Program*; AIA; EPA: Washington, DC, USA, 1992.
64. Alwan, Z.; Greenwood, D.; Gledson, B. Rapid LEED Evaluation Performed with BIM Based Sustainability Analysis on a Virtual Construction Project. *Constr. Innov.* **2015**, *15*, 134–150. [CrossRef]
65. Ansah, M.K.; Chen, X.; Yang, H.; Lu, L.; Lam, P.T.I. A Review and Outlook for Integrated BIM Application in Green Building Assessment. *Sustain. Cities Soc.* **2019**, *48*, 101576. [CrossRef]
66. Ilhan, B.; Yaman, H. Green Building Assessment Tool (GBAT) for Integrated BIM-Based Design Decisions. *Autom. Constr.* **2016**, *70*, 26–37. [CrossRef]
67. Li, Y.; Chen, X.; Wang, X.; Xu, Y.; Chen, P.-H. A Review of Studies on Green Building Assessment Methods by Comparative Analysis. *Energy Build.* **2017**, *146*, 152–159. [CrossRef]
68. Zhang, Y.; Kang, J.; Jin, H. A Review of Green Building Development in China from the Perspective of Energy Saving. *Energies* **2018**, *11*, 334. [CrossRef]
69. World Green Building Council What is Green Building. Available online: https://www.worldgbc.org/what-green-building (accessed on 7 August 2022).
70. Wu, Z.; He, Q.; Yang, K.; Zhang, J.; Xu, K. Investigating the Dynamics of China's Green Building Policy Development from 1986 to 2019. *Int. J. Environ. Res. Public Health* **2020**, *18*, 196. [CrossRef] [PubMed]
71. Apichayakul, P.; Pachanapan, P.; Vongkunghae, A.; Tantanee, S. Isolated Energy Management Learning Platform through Smart and Green Building Design: A Case Study of USIS Building, Naresuan University. In Proceedings of the 2020 International Conference and Utility Exhibition on Energy, Environment and Climate Change (ICUE), Pattaya, Thailand, 20–22 October 2020; pp. 1–5.
72. Cole, L.B. Green Building Literacy: A Framework for Advancing Green Building Education. *Int. J. STEM Educ.* **2019**, *6*, 18. [CrossRef]
73. He, B.-J.; Zhao, D.-X.; Gou, Z. Integration of Low-Carbon Eco-City, Green Campus and Green Building in China. In *Green Building in Developing Countries*; Gou, Z., Ed.; Green Energy and Technology; Springer International Publishing: Berlin/Heidelberg, Germany; Cham, Switzerland, 2020; pp. 49–78. ISBN 978-3-030-24649-5.
74. Ravasio, L.; Riise, R.; Sveen, S.E. Green Buildings in the Arctic Region: A Literature Review. *E3S Web Conf.* **2020**, *172*, 16002. [CrossRef]
75. Zhang, Y.; Wang, H.; Gao, W.; Wang, F.; Zhou, N.; Kammen, D.M.; Ying, X. A Survey of the Status and Challenges of Green Building Development in Various Countries. *Sustainability* **2019**, *11*, 5385. [CrossRef]
76. Zimmermann, R.K.; Skjelmose, O.; Jensen, K.G.; Jensen, K.K.; Birgisdottir, H. Categorizing Building Certification Systems According to the Definition of Sustainable Building. *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *471*, 092060. [CrossRef]
77. US Green Building Council The Definition of Green Building. Available online: https://www.usgbc.org/articles/what-green-building (accessed on 7 August 2022).
78. Ferrari, S.; Zoghi, M.; Blázquez, T.; Dall'O', G. New Level(s) Framework: Assessing the Affinity between the Main International Green Building Rating Systems and the European Scheme. *Renew. Sustain. Energy Rev.* **2022**, *155*, 111924. [CrossRef]
79. Harja, M.; Gencel, O.; Sari, A.; Sutcu, M.; Erdogmus, E.; Hekimoglu, G. Production and Characterization of Natural Clay-Free Green Building Brick Materials Using Water Treatment Sludge and Oak Wood Ash. *Arch. Civ. Mech. Eng.* **2022**, *22*, 79. [CrossRef]
80. Hu, M.; Skibniewski, M. Green Building Construction Cost Surcharge: An Overview. *J. Archit. Eng.* **2021**, *27*, 4021034. [CrossRef]

81. Huseien, G.F.; Hafizah, A.N.K.; Mirza, J. Nanotechnology for Smart Concrete. In *Emerging materials and technologies*, 1st ed.; CRC Press: Boca Raton, FL, USA; Abingdon, UK; Oxon, UK, 2022; ISBN 978-1-00-319614-3.
82. Cao, C. Comparative Analysis of German Dgnb and Chinese Green Building Evaluation Standards. *J. Phys. Conf. Ser.* **2022**, *2202*, 12033. [CrossRef]
83. Jun, L.; Chunfeng, L.; Fang, P.; Jing, Z. A Preliminary Study on the Evaluation Index of Green Service Area under the Concept of New Green Building Evaluation Standard. *E3S Web Conf.* **2021**, *233*, 1109. [CrossRef]
84. Li, X.-J.; Wang, C.; Chen, W.; Bora, S.; Yap, J.B.H.; Samuel, B. Green Building Performance Assessment in China Using a Cloud Model. *Environ. Dev. Sustain.* **2021**, *24*, 11626–11650. [CrossRef]
85. Ma, G.; Liu, T.; Shang, S. Improving the Climate Adaptability of Building Green Retrofitting in Different Regions: A Weight Correction System for Chinese National Standard. *Sustain. Cities Soc.* **2021**, *69*, 102843. [CrossRef]
86. Wu, X.; Lin, B.; Papachristos, G.; Liu, P.; Zimmermann, N. A Holistic Approach to Evaluate Building Performance Gap of Green Office Buildings: A Case Study in China. *Build. Environ.* **2020**, *175*, 106819. [CrossRef]
87. Xie, B.-C.; Zhai, J.-X.; Sun, P.-C.; Ma, J.-J. Assessment of Energy and Emission Performance of a Green Scientific Research Building in Beijing, China. *Energy Build.* **2020**, *224*, 110248. [CrossRef]
88. Li, W.F. The Study on Promotion of Chinese Green Energy-Saving Buildings. *Appl. Mech. Mater.* **2014**, *672–674*, 1847–1850. [CrossRef]
89. Ding, Z.; Fan, Z.; Tam, V.W.Y.; Bian, Y.; Li, S.; Illankoon, I.M.C.S.; Moon, S. Green Building Evaluation System Implementation. *Build. Environ.* **2018**, *133*, 32–40. [CrossRef]
90. Zhang, J.; Xiong, J. Optimization Strategies for Green Substation Assessment System in China: Based on LEED and Chinese Green-Building Evaluation Standard. *Adv. Mater. Res.* **2013**, *689*, 139–143. [CrossRef]
91. Shen, Y.; Faure, M. Green Building in China. *Int. Environ. Agreem.* **2021**, *21*, 183–199. [CrossRef]
92. Dobrovolskienė, N.; Tamošiūnienė, R. An Index to Measure Sustainability of a Business Project in the Construction Industry: Lithuanian Case. *Sustainability* **2015**, *8*, 14. [CrossRef]
93. Illankoon, I.M.C.S.; Tam, V.W.Y.; Le, K.N. Environmental, Economic, and Social Parameters in International Green Building Rating Tools. *J. Prof. Issues Eng. Educ. Pract.* **2017**, *143*, 5016010. [CrossRef]
94. Yu, Z.; Xu, W.; Chen, X.; Sun, D.; Zhang, J.; Lu, F.; Liu, C. Progress in Energy Efficiency Standards of Residential Buildings in China's Severe Cold and Cold Zones. In Proceedings of the E3S Web of Conferences, Proceedings of the 13th REHVA World Congress CLIMA 2019, Bucharest, Romania, 26–29 May 2019; EDP Sciences: Les Ulis, France, 2019; Volume 111, p. 3032.
95. Liu, G.; Li, X.; Tan, Y.; Zhang, G. Building Green Retrofit in China: Policies, Barriers and Recommendations. *Energy Policy* **2020**, *139*, 111356. [CrossRef]
96. Ministry of Housing and Urban-Rural Development. *New Urban Building Energy Efficient Standard System*; Ministry of Housing and Urban-Rural Development: Beijing, China, 1996.
97. Liu, G.; Tan, Y.; Li, X. China's Policies of Building Green Retrofit: A State-of-the-Art Overview. *Build. Environ.* **2020**, *169*, 106554. [CrossRef]
98. Ministry of Housing and Urban-Rural Development. *Evaluation Standards for Green Building (Version 1)*; Ministry of Housing and Urban-Rural Development: Beijing, China, 2006.
99. Chen, H.; Chen, W. Potential Impacts of Coal Substitution Policy on Regional Air Pollutants and Carbon Emission Reductions for China's Building Sector during the 13th Five-Year Plan Period. *Energy Policy* **2019**, *131*, 281–294. [CrossRef]
100. Song, M.; Liu, X.; Hu, S.; Wen, Q.; Yan, D. Building a Greener Future—Progress of the Green Building Technology in the "13th Five-Year Plan" of China. *Build. Simul.* **2022**, *15*, 1705–1707. [CrossRef]
101. Zhang, D.; Wu, W.; Fang, P. Research on the Development of Green Buildings in China. In *the IOP Conference Series: Earth and Environmental Science, Proceedings of the 2020 International Conference on Green Energy, Environment and Sustainable Development, Wuhan, China, 24–25 April 2020*; IOP Publishing: Bristol, UK, 2020; Volume 555, p. 12095.
102. He, W.; Liu, P.; Lin, B.; Zhou, H.; Chen, X. Green Finance Support for Development of Green Buildings in China: Effect, Mechanism, and Policy Implications. *Energy Policy* **2022**, *165*, 112973. [CrossRef]
103. Kong, F.; He, L. Impacts of Supply-Sided and Demand-Sided Policies on Innovation in Green Building Technologies: A Case Study of China. *J. Clean. Prod.* **2021**, *294*, 126279. [CrossRef]
104. Chang, R.; Soebarto, V.; Zhao, Z.; Zillante, G. Facilitating the Transition to Sustainable Construction: China's Policies. *J. Clean. Prod.* **2016**, *131*, 534–544. [CrossRef]
105. Huang, W.; Wang, M.; Jun, W.; Kun, G.; Song, L.; Liu, C. *China Low-Carbon Healthy City, Technology Assessment and Practice*; Springer: Berlin/Heidelberg, Germany, 2016.
106. Ming, Z.; Ximei, L.; Na, L.; Song, X. Overall Review of Renewable Energy Tariff Policy in China: Evolution, Implementation, Problems and Countermeasures. *Renew. Sustain. Energy Rev.* **2013**, *25*, 260–271. [CrossRef]
107. Wang, G.; Li, Y.; Zuo, J.; Hu, W.; Nie, Q.; Lei, H. Who Drives Green Innovations? Characteristics and Policy Implications for Green Building Collaborative Innovation Networks in China. *Renew. Sustain. Energy Rev.* **2021**, *143*, 110875. [CrossRef]
108. Liu, Z.; Liu, Y.; He, B.-J.; Xu, W.; Jin, G.; Zhang, X. Application and Suitability Analysis of the Key Technologies in Nearly Zero Energy Buildings in China. *Renew. Sustain. Energy Rev.* **2019**, *101*, 329–345. [CrossRef]
109. Ahn, Y.H.; Wang, Y.; Lee, K.H.; Jeon, M.H. The Greening of Affordable Housing Through Public and Private Partnerships: Development of a Model for Green Affordable Housing. *J. Green Build.* **2014**, *9*, 93–112. [CrossRef]

110. Gao, L.; Yang, W.; Fu, J.; Xu, M. Study on Effect of Public-Private Partnership (PPP) Model on the Construction of Smart City. *Fresenius Environ. Bull.* **2020**, *29*, 4398–4404.
111. Yang, X.; Zhang, J.; Shen, G.Q.; Yan, Y. Incentives for Green Retrofits: An Evolutionary Game Analysis on Public-Private-Partnership Reconstruction of Buildings. *J. Clean. Prod.* **2019**, *232*, 1076–1092. [CrossRef]
112. International Institute of Green Finance, Central University of Finance and Economics. *Green PPP Market Progress and Related Recommendations for 2020*; International Institute of Green Finance, Central University of Finance and Economics: Beijing, China, 2021.
113. Yu, F.L.T.; Yuen, T.W.K.; Tang, E.C.H. Sustainable Development and Green Education in Mainland China, Taiwan and Hong Kong. *Int. J. Plur. Econ. Educ.* **2019**, *10*, 69. [CrossRef]
114. Choi, M.Y.; Jiang, D.; Ru, G.; Li, F.; Cao, X. *Education for Sustainable Development Practice in China*; Institute for Global Environmental Strategies: Hayama, Japan, 2009; Available online: http://enviroscope.iges.or.jp/modules/envirolib/view.php?docid=2389 (accessed on 7 August 2022).
115. Niu, D.; Jiang, D.; Li, F. Higher Education for Sustainable Development in China. *Int. J. Sustain. High. Educ.* **2010**, *11*, 153–162. [CrossRef]
116. Gao, Y.; Yang, G.; Xie, Q. Spatial-Temporal Evolution and Driving Factors of Green Building Development in China. *Sustainability* **2020**, *12*, 2773. [CrossRef]
117. China Real Estate Association. *China Green Building Market Development Research Report 2020*; China Real Estate Association: Beijing, China, 2021.
118. Wu, Z.; Li, H.; Feng, Y.; Luo, X.; Chen, Q. Developing a Green Building Evaluation Standard for Interior Decoration: A Case Study of China. *Build. Environ.* **2019**, *152*, 50–58. [CrossRef]
119. Jiang, S.; Wang, N.; Wu, J. Combining BIM and Ontology to Facilitate Intelligent Green Building Evaluation. *J. Comput. Civ. Eng.* **2018**, *32*, 4018039. [CrossRef]
120. Wu, Z.; Shen, L.; Ann, T.; Zhang, X. A Comparative Analysis of Waste Management Requirements between Five Green Building Rating Systems for New Residential Buildings. *J. Clean. Prod.* **2016**, *112*, 895–902. [CrossRef]
121. Shao, Q.-G.; Liou, J.; Weng, S.-S.; Chuang, Y.-C. Improving the Green Building Evaluation System in China Based on the DANP Method. *Sustainability* **2018**, *10*, 1173. [CrossRef]
122. Yu, W.; Li, B.; Yang, X.; Wang, Q. A Development of a Rating Method and Weighting System for Green Store Buildings in China. *Renew. Energy* **2015**, *73*, 123–129. [CrossRef]
123. Liu, Z.W.; Gao, P.Z.; Kang, Y.W. Low-Carbon Building Assessment and Model Construction. *Appl. Mech. Mater.* **2013**, *361–363*, 903–907. [CrossRef]
124. Li, W.; Fang, G.; Yang, L. The Effect of LEED Certification on Office Rental Values in China. *Sustain. Energy Technol. Assess.* **2021**, *45*, 101182. [CrossRef]
125. Pushkar, S. LEED-CI V3 and V4 Silver and Gold Projects in China and the US. *Appl. Sci.* **2020**, *10*, 4524. [CrossRef]
126. Zou, Y. Certifying Green Buildings in China: LEED vs. 3-Star. *J. Clean. Prod.* **2019**, *208*, 880–888. [CrossRef]
127. Liu, C.; Wang, F.; MacKillop, F. A Critical Discussion of the BREEAM Communities Method as Applied to Chinese Eco-Village Assessment. *Sustain. Cities Soc.* **2020**, *59*, 102172. [CrossRef]
128. International Finance Corporation. *China Green Building Market Snapshot 2020*; World Bank Group: Washington, DC, USA, 2021.
129. MacNaughton, P.; Cao, X.; Buonocore, J.; Cedeno-Laurent, J.; Spengler, J.; Bernstein, A.; Allen, J. Energy Savings, Emission Reductions, and Health Co-Benefits of the Green Building Movement. *J. Expo. Sci. Environ. Epidemiol.* **2018**, *28*, 307–318. [CrossRef]
130. Baumgärtel, K.; Scherer, R.J. Automatic Ontology-Based Green Building Design Parameter Variation and Evaluation in Thermal Energy Building Performance Analyses. In *The eWork and eBusiness in Architecture, Engineering and Construction—Proceedings of the 11th European Conference on Product and Process Modelling, ECPPM 2016, Limassol, Cyprus, 7–9 September 2016*; Taylor & Francis Ltd.: Oxfordshire, UK, 2016; pp. 667–672.
131. Li, Y.; Gao, X.; Liu, X.; Zhang, R.; Wu, Y. Green Construction Evaluation System Based on BIM Distributed Cloud Service. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *760*, 12055. [CrossRef]
132. He, Y.; Kvan, T.; Liu, M.; Li, B. How Green Building Rating Systems Affect Designing Green. *Build. Environ.* **2018**, *133*, 19–31. [CrossRef]
133. Awadh, O. Sustainability and Green Building Rating Systems: LEED, BREEAM, GSAS and Estidama Critical Analysis. *J. Build. Eng.* **2017**, *11*, 25–29. [CrossRef]
134. Freitas, I.A.S.; Zhang, X. Green Building Rating Systems in Swedish Market-A Comparative Analysis between LEED, BREEAM SE, GreenBuilding and Miljöbyggnad. *Energy Procedia* **2018**, *153*, 402–407. [CrossRef]
135. Zhang, Y.; Wang, J.; Hu, F.; Wang, Y. Comparison of Evaluation Standards for Green Building in China, Britain, United States. *Renew. Sustain. Energy Rev.* **2017**, *68*, 262–271. [CrossRef]
136. Green Building Council Australia. Green Star Certification; 2016. Available online: https://new.gbca.org.au/ (accessed on 8 August 2022).
137. Doan, D.T.; Ghaffarianhoseini, A.; Naismith, N.; Zhang, T.; Ghaffarianhoseini, A.; Tookey, J. A Critical Comparison of Green Building Rating Systems. *Build. Environ.* **2017**, *123*, 243–260. [CrossRef]
138. Naranjo, A.; Colonia, A.; Mesa, J.; Maury, H.; Maury-Ramírez, A. State-of-the-Art Green Roofs: Technical Performance and Certifications for Sustainable Construction. *Coatings* **2020**, *10*, 69. [CrossRef]

139. United Nations Environment Programme. *UN Environment 2018 Annual Report*; United Nations Environment Programme: Nairobi, Kenya, 2019.
140. China Association of Building Energy Efficiency. *China Building Energy Consumption Study Report (2020)*; China Association of Building Energy Efficiency: Beijing, China, 2021.
141. Sun, W.; Sun, Y.; Xu, L.; Chen, X.; Zai, D. Research on Energy Consumption Constitution and Energy Efficiency Strategies of Residential Buildings in China Based on Carbon Neutral Demand. *Sustainability* **2022**, *14*, 2741. [CrossRef]
142. Hu, S.; Jiang, Y.; Yan, D. *China Building Energy Use and Carbon Emission Yearbook 2021: A Roadmap to Carbon Neutrality by 2060*; Springer Nature Singapore: Singapore, 2022; ISBN 9789811675775.
143. Cristino, T.M.; Lotufo, F.A.; Delinchant, B.; Wurtz, F.; Faria Neto, A. A Comprehensive Review of Obstacles and Drivers to Building Energy-Saving Technologies and Their Association with Research Themes, Types of Buildings, and Geographic Regions. *Renew. Sustain. Energy Rev.* **2021**, *135*, 110191. [CrossRef]
144. Hu, X.; Xiang, Y.; Zhang, H.; Lin, Q.; Wang, W.; Wang, H. Active–Passive Combined Energy-Efficient Retrofit of Rural Residence with Non-Benchmarked Construction: A Case Study in Shandong Province, China. *Energy Rep.* **2021**, *7*, 1360–1373. [CrossRef]
145. Huang, C.; Ma, J.; Song, K. Homeowners' Willingness to Make Investment in Energy Efficiency Retrofit of Residential Buildings in China and Its Influencing Factors. *Energies* **2021**, *14*, 1260. [CrossRef]
146. Lu, W.; Webster, C.; Peng, Y.; Chen, X.; Zhang, X. Estimating and Calibrating the Amount of Building-Related Construction and Demolition Waste in Urban China. *Int. J. Constr. Manag.* **2017**, *17*, 13–24. [CrossRef]
147. Chen, X.; Xu, L.; Zhu, R.; Ma, Q.; Shi, Y.; Lu, Z. Changes and Characteristics of Green Infrastructure Network Based on Spatio-Temporal Priority. *Land* **2022**, *11*, 901. [CrossRef]
148. Laurenz, J.; Belausteguigoitia, J.; de la Fuente, A.; Roehr, D. Green Urban (RE) Generation: A Research and Practice Methodology to Better Implement Green Urban Infrastructure Solutions. *Land* **2021**, *10*, 1376. [CrossRef]
149. Leising, E.; Quist, J.; Bocken, N. Circular Economy in the Building Sector: Three Cases and a Collaboration Tool. *J. Clean. Prod.* **2018**, *176*, 976–989. [CrossRef]
150. Ricci, L. Integrated Approaches to Ecosystem Services: Linking Culture, Circular Economy and Environment through the Re-Use of Open Spaces and Buildings in Europe. *Land* **2022**, *11*, 1161. [CrossRef]
151. Lin, Z.; Wang, Y.; Ye, X.; Wan, Y.; Lu, T.; Han, Y. Effects of Low-Carbon Visualizations in Landscape Design Based on Virtual Eye-Movement Behavior Preference. *Land* **2022**, *11*, 782. [CrossRef]
152. Well, F.; Ludwig, F. Integrated Planning and Implementation of a Blue-Green Architecture Project by Applying a Design-Build Teaching Approach. *Land* **2022**, *11*, 762. [CrossRef]
153. Zhang, L.; Ma, X.; Ock, Y.-S.; Qing, L. Research on Regional Differences and Influencing Factors of Chinese Industrial Green Technology Innovation Efficiency Based on Dagum Gini Coefficient Decomposition. *Land* **2022**, *11*, 122. [CrossRef]
154. MacNaughton, P.; Spengler, J.; Vallarino, J.; Santanam, S.; Satish, U.; Allen, J. Environmental Perceptions and Health before and after Relocation to a Green Building. *Build. Environ.* **2016**, *104*, 138–144. [CrossRef]
155. Dwaikat, L.N.; Ali, K.N. Green Buildings Life Cycle Cost Analysis and Life Cycle Budget Development: Practical Applications. *J. Build. Eng.* **2018**, *18*, 303–311. [CrossRef]
156. Balaban, O.; Puppim de Oliveira, J.A. Sustainable Buildings for Healthier Cities: Assessing the Co-Benefits of Green Buildings in Japan. *J. Clean. Prod.* **2017**, *163*, S68–S78. [CrossRef]
157. Eisenstein, W.; Fuertes, G.; Kaam, S.; Seigel, K.; Arens, E.; Mozingo, L. Climate Co-Benefits of Green Building Standards: Water, Waste and Transportation. *Build. Res. Inf.* **2017**, *45*, 828–844. [CrossRef]
158. Worden, K.; Hazer, M.; Pyke, C.; Trowbridge, M. Using LEED Green Rating Systems to Promote Population Health. *Build. Environ.* **2020**, *172*, 106550. [CrossRef]
159. Wu, W.; Issa, R.R.A. BIM Execution Planning in Green Building Projects: LEED as a Use Case. *J. Manag. Eng.* **2015**, *31*, 402–407. [CrossRef]
160. Chen, X.; Lu, W.; Xue, F.; Xu, J. A Cost-Benefit Analysis of Green Buildings with Respect to Construction Waste Minimization Using Big Data in Hong Kong. *J. Green Build.* **2018**, *13*, 61–76. [CrossRef]
161. Kim, K.H.; Jeon, S.-S.; Irakoze, A.; Son, K. A Study of the Green Building Benefits in Apartment Buildings According to Real Estate Prices: Case of Non-Capital Areas in South Korea. *Sustainability* **2020**, *12*, 2206. [CrossRef]
162. Liu, Y.; Guo, X.; Hu, F. Cost-Benefit Analysis on Green Building Energy Efficiency Technology Application: A Case in China. *Energy Build.* **2014**, *82*, 37–46. [CrossRef]
163. Zhang, L.; Wu, J.; Liu, H. Turning Green into Gold: A Review on the Economics of Green Buildings. *J. Clean. Prod.* **2018**, *172*, 2234–2245. [CrossRef]
164. Sustainable Energy Authority of Ireland. *Guide to Building Energy Rating for Homeowners*; Sustainable Energy Authority of Ireland: Dublin, Ireland, 2014.
165. Zhang, L.; Liu, H.; Wu, J. The Price Premium for Green-Labelled Housing: Evidence from China. *Urban Stud.* **2017**, *54*, 3524–3541. [CrossRef]
166. Chegut, A.; Eichholtz, P.; Holtermans, R. Energy Efficiency and Economic Value in Affordable Housing. *Energy Policy* **2016**, *97*, 39–49. [CrossRef]
167. Heinzle, S.L.; Boey Ying Yip, A.; Low Yu Xing, M. The Influence of Green Building Certification Schemes on Real Estate Investor Behaviour: Evidence from Singapore. *Urban Stud.* **2013**, *50*, 1970–1987. [CrossRef]

168. Wiencke, A. Willingness to Pay for Green Buildings: Empirical Evidence from Switzerland. *J. Sustain. Real Estate* **2013**, *5*, 111–130. [CrossRef]
169. Hu, H.; Geertman, S.; Hooimeijer, P. The Willingness to Pay for Green Apartments: The Case of Nanjing, China. *Urban Stud.* **2014**, *51*, 3459–3478. [CrossRef]
170. Houghton, A.; Castillo-Salgado, C. Health Co-Benefits of Green Building Design Strategies and Community Resilience to Urban Flooding: A Systematic Review of the Evidence. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1519. [CrossRef]
171. Xie, H.; Clements-Croome, D.; Wang, Q. Move beyond Green Building: A Focus on Healthy, Comfortable, Sustainable and Aesthetical Architecture. *Intell. Build. Int.* **2017**, *9*, 88–96. [CrossRef]
172. Scofield, J.H.; Cornell, J. A Critical Look at "Energy Savings, Emissions Reductions, and Health Co-Benefits of the Green Building Movement". *J. Expo. Sci. Environ. Epidemiol.* **2019**, *29*, 584–593. [CrossRef]
173. Dodo, Y.A.; Kandar, M.Z.; Ossen, D.R.; Jibril, J.D.; Bornoma, A.H.; Abubakar, A.I. Importance of a View Window in Rating Green Office Buildings. *Adv. Mater. Res.* **2013**, *689*, 180–183. [CrossRef]
174. Ekhaese, E.N.; Adejuwon, G.A.; Evbuoma, I.K. Promoting Green Urbanism in Nigerian Purlieus as Therapy for Psychological Wellbeing/Health. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *665*, 012015. [CrossRef]
175. Hwang, T.; Kinm, J.T. Effects of Indoor Lighting on Occupants' Visual Comfort and Eye Health in a Green Building. *Indoor Built Environ.* **2011**, *20*, 75–90. [CrossRef]
176. Buonocore, J.J.; Luckow, P.; Norris, G.; Spengler, J.D.; Biewald, B.; Fisher, J.; Levy, J.I. Health and Climate Benefits of Different Energy-Efficiency and Renewable Energy Choices. *Nat. Clim. Chang.* **2016**, *6*, 100–105. [CrossRef]
177. Cedeño-Laurent, J.; Williams, A.; MacNaughton, P.; Cao, X.; Eitland, E.; Spengler, J.; Allen, J. Building Evidence for Health: Green Buildings, Current Science, and Future Challenges. *Annu. Rev. Public Health* **2018**, *39*, 291–308. [CrossRef] [PubMed]
178. Holmgren, M.; Kabanshi, A.; Sörqvist, P. Occupant Perception of "Green" Buildings: Distinguishing Physical and Psychological Factors. *Build. Environ.* **2017**, *114*, 140–147. [CrossRef]
179. Shi, P. Study on the Passive Engergy Saving Design of the Canteen of University Aided by BIM—Taking Chongqing Area as an Example. Master Dissertation, Chongqing Univeristy, Chongqing, China, 2016.
180. Allen, J.G.; MacNaughton, P.; Satish, U.; Santanam, S.; Vallarino, J.; Spengler, J.D. Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. *Environ. Health Perspect.* **2016**, *124*, 805–812. [CrossRef] [PubMed]
181. Elnaklah, R.A.; Natarajan, S. A Comparison of Indoor Air Quality and Employee Absenteeism in 'Local' and 'Imported' Green Building Standards. *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *609*, 42089. [CrossRef]
182. Elnaklah, R.; Fosas, D.; Natarajan, S. Indoor Environment Quality and Work Performance in "Green" Office Buildings in the Middle East. In Proceedings of the Building Simulation; Springer: Berlin/Heidelberg, Germany, 2020; Volume 13, pp. 1043–1062.
183. Dreyer, B.C.; Coulombe, S.; Whitney, S.; Riemer, M.; Labbé, D. Beyond Exposure to Outdoor Nature: Exploration of the Benefits of a Green Building's Indoor Environment on Wellbeing. *Front. Psychol.* **2018**, *9*, 1583. [CrossRef]
184. Song, Y. Research on Thew Optimization Stratedgy of Exisiting Catering Space in Universities from the Perspective of Environmental Psychology—Taking Wenyuan Restuarant Space Optimization of Shandong Jianzhu Univeristy as an Example. Master Dissertation, Shandong Jianzhu University, Jinan, China, 2020.
185. Abdelaal, F.; Guo, B.H.W. Stakeholders' Perspectives on BIM and LCA for Green Buildings. *J. Build. Eng.* **2022**, *48*, 103931. [CrossRef]
186. Raouf, A.M.I.; Al-Ghamdi, S.G. Building Information Modelling and Green Buildings: Challenges and Opportunities. *Archit. Eng. Des. Manag.* **2019**, *15*, 1–28. [CrossRef]
187. Bastos Porsani, G.; Del Valle de Lersundi, K.; Sánchez-Ostiz Gutiérrez, A.; Fernández Bandera, C. Interoperability between Building Information Modelling (BIM) and Building Energy Model (BEM). *Appl. Sci.* **2021**, *11*, 2167. [CrossRef]
188. Hamledari, H.; McCabe, B.; Davari, S.; Shahi, A. Automated Schedule and Progress Updating of IFC-Based 4D BIMs. *J. Comput. Civ. Eng.* **2017**, *31*, 4017012. [CrossRef]
189. Kameli, M.; Hosseinalipour, M.; Majrouhi Sardroud, J.; Ahmed, S.M.; Behruyan, M. Improving Maintenance Performance by Developing an IFC BIM/RFID-Based Computer System. *J. Ambient. Intell. Humaniz. Comput.* **2021**, *12*, 3055–3074. [CrossRef]
190. Mirahadi, F.; McCabe, B.; Shahi, A. IFC-Centric Performance-Based Evaluation of Building Evacuations Using Fire Dynamics Simulation and Agent-Based Modeling. *Autom. Constr.* **2019**, *101*, 1–16. [CrossRef]
191. Vieira, R.; Carreira, P.; Domingues, P.; Costa, A.A. Supporting Building Automation Systems in BIM/IFC: Reviewing the Existing Information Gap. *Eng. Constr. Archit. Manag.* **2020**, *27*, 1357–1375. [CrossRef]
192. Zhu, J.; Wang, X.; Wang, P.; Wu, Z.; Kim, M.J. Integration of BIM and GIS: Geometry from IFC to Shapefile Using Open-Source Technology. *Autom. Constr.* **2019**, *102*, 105–119. [CrossRef]
193. Ham, Y.; Golparvar-Fard, M. Mapping Actual Thermal Properties to Building Elements in GbXML-Based BIM for Reliable Building Energy Performance Modeling. *Autom. Constr.* **2015**, *49*, 214–224. [CrossRef]
194. Lai, H.; Deng, X. Interoperability Analysis of Ifc-Based Data Exchange between Heterogeneous BIM Software. *J. Civ. Eng. Manag.* **2018**, *24*, 537–555. [CrossRef]
195. Theißen, S.; Höper, J.; Drzymalla, J.; Wimmer, R.; Markova, S.; Meins-Becker, A.; Lambertz, M. Using Open BIM and IFC to Enable a Comprehensive Consideration of Building Services within a Whole-Building LCA. *Sustainability* **2020**, *12*, 5644. [CrossRef]

196. Adouane, K.; Stouffs, R.; Janssen, P.; Domer, B. A Model-Based Approach to Convert a Building BIM-IFC Data Set Model into CityGML. *J. Spat. Sci.* **2020**, *65*, 257–280. [CrossRef]
197. Kardinal Jusuf, S.; Mousseau, B.; Godfroid, G.; Soh Jin Hui, V. Integrated Modeling of CityGML and IFC for City/Neighborhood Development for Urban Microclimates Analysis. *Energy Procedia* **2017**, *122*, 145–150. [CrossRef]
198. Ding, X.; Yang, J.; Liu, L.; Huang, W.; Wu, P. Integrating IFC and CityGML Model at Schema Level by Using Linguistic and Text Mining Techniques. *IEEE Access* **2020**, *8*, 56429–56440. [CrossRef]
199. Lee, Y.-C.; Eastman, C.M.; Lee, J.-K. Validations for Ensuring the Interoperability of Data Exchange of a Building Information Model. *Autom. Constr.* **2015**, *58*, 176–195. [CrossRef]
200. Sattler, L.; Lamouri, S.; Pellerin, R.; Maigne, T. Interoperability Aims in Building Information Modeling Exchanges: A Literature Review. *IFAC-PapersOnLine* **2019**, *52*, 271–276. [CrossRef]
201. Hwang, B.; Shan, M.; Supa'at, N.N.B. Green Commercial Building Projects in Singapore: Critical Risk Factors and Mitigation Measures. *Sustain. Cities Soc.* **2017**, *30*, 237–247. [CrossRef]
202. Hwang, B.-G.; Zhao, X.; Tan, L.L.G. Green Building Projects: Schedule Performance, Influential Factors and Solutions. *Eng. Constr. Archit. Manag.* **2015**, *22*, 327–346. [CrossRef]
203. Venkataraman, V.; Cheng, J.C.P. Critical Success and Failure Factors for Managing Green Building Projects. *J. Archit. Eng.* **2018**, *24*, 4018025. [CrossRef]
204. Ghaffarianhoseini, A.; Tookey, J.; Ghaffarianhoseini, A.; Naismith, N.; Azhar, S.; Efimova, O.; Raahemifar, K. Building Information Modelling (BIM) Uptake: Clear Benefits, Understanding Its Implementation, Risks and Challenges. *Renew. Sustain. Energy Rev.* **2017**, *75*, 1046–1053. [CrossRef]
205. Najjar, M.; Figueiredo, K.; Palumbo, M.; Haddad, A. Integration of BIM and LCA: Evaluating the Environmental Impacts of Building Materials at an Early Stage of Designing a Typical Office Building. *J. Build. Eng.* **2017**, *14*, 115–126. [CrossRef]
206. Song, Y.; Wang, X.; Tan, Y.; Wu, P.; Sutrisna, M.; Cheng, J.; Hampson, K. Trends and Opportunities of BIM-GIS Integration in the Architecture, Engineering and Construction Industry: A Review from a Spatio-Temporal Statistical Perspective. *Int. J. Geo. Inf.* **2017**, *6*, 397. [CrossRef]
207. Zhang, L.; Chu, Z.; Song, H. Understanding the Relation between BIM Application Behavior and Sustainable Construction: A Case Study in China. *Sustainability* **2019**, *12*, 306. [CrossRef]
208. Ardani, J.A.; Utomo, C.; Rahmawati, Y. Model Ownership and Intellectual Property Rights for Collaborative Sustainability on Building Information Modeling. *Buildings* **2021**, *11*, 346. [CrossRef]
209. Baharom, M.H.; Habib, S.N.H.A.; Ismail, S. Building Information Modelling (BIM): Contractual Issues of Intellectual Property Rights (IPR) in Construction Projects. *Int. J. Sustain. Constr. Eng. Technol.* **2021**, *12*, 170–178. [CrossRef]
210. Dao, T.-N.; Chen, P.-H.; Nguyen, T.-Q. Critical Success Factors and a Contractual Framework for Construction Projects Adopting Building Information Modeling in Vietnam. *Int. J. Civ. Eng.* **2021**, *19*, 85–102. [CrossRef]
211. Alreshidi, E.; Mourshed, M.; Rezgui, Y. Factors for Effective BIM Governance. *J. Build. Eng.* **2017**, *10*, 89–101. [CrossRef]
212. Alreshidi, E.; Mourshed, M.; Rezgui, Y. Requirements for Cloud-Based BIM Governance Solutions to Facilitate Team Collaboration in Construction Projects. *Requir. Eng.* **2018**, *23*, 1–31. [CrossRef]
213. Fan, S.-L. Intellectual Property Rights in Building Information Modeling Application in Taiwan. *J. Constr. Eng. Manage.* **2014**, *140*, 4013058. [CrossRef]
214. Hsu, K.-M.; Hsieh, T.-Y.; Chen, J.-H. Legal Risks Incurred under the Application of BIM in Taiwan. *Proc. Inst. Civ. Eng. Forensic Eng.* **2015**, *168*, 127–133. [CrossRef]
215. Jo, T.M.; Ishak, S.S.M.; Rashid, Z.Z.A. Overview of the Legal Aspects and Contract Requirements of the BIM Practice in Malaysian Construction Industry. *MATEC Web Conf.* **2018**, *203*, 2011. [CrossRef]
216. Deng, W.; Yang, T.; Tang, L.; Tang, Y.-T. Barriers and Policy Recommendations for Developing Green Buildings from Local Government Perspective: A Case Study of Ningbo China. *Intell. Build. Int.* **2018**, *10*, 61–77. [CrossRef]
217. Geng, Y.; Ji, W.; Wang, Z.; Lin, B.; Zhu, Y. A Review of Operating Performance in Green Buildings: Energy Use, Indoor Environmental Quality and Occupant Satisfaction. *Energy Build.* **2019**, *183*, 500–514. [CrossRef]
218. Chegut, A.; Eichholtz, P.; Kok, N. The Price of Innovation: An Analysis of the Marginal Cost of Green Buildings. *J. Environ. Econ. Manag.* **2019**, *98*, 102248. [CrossRef]
219. Wu, Z.; Yu, A.T.W.; Poon, C.S. Promoting Effective Construction and Demolition Waste Management towards Sustainable Development: A Case Study of Hong Kong. *Sustain. Dev.* **2020**, *28*, 1713–1724. [CrossRef]
220. Dwaikat, L.N.; Ali, K.N. Green Buildings Cost Premium: A Review of Empirical Evidence. *Energy Build.* **2016**, *110*, 396–403. [CrossRef]
221. Taemthong, W.; Chaisaard, N. An Analysis of Green Building Costs Using a Minimum Cost Concept. *J. Green Build.* **2019**, *14*, 53–78. [CrossRef]
222. Nguyen, H.-T.; Skitmore, M.; Gray, M.; Zhang, X.; Olanipekun, A.O. Will Green Building Development Take off? An Exploratory Study of Barriers to Green Building in Vietnam. *Resour. Conserv. Recycl.* **2017**, *127*, 8–20. [CrossRef]
223. Li, Q.; Long, R.; Chen, H.; Chen, F.; Wang, J. Visualized Analysis of Global Green Buildings: Development, Barriers and Future Directions. *J. Clean. Prod.* **2020**, *245*, 118775. [CrossRef]
224. Lv, Z.; Zhang, D. Analysis of the Life Cycle Stage of Prefabricated Buildings. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *330*, 022075. [CrossRef]

225. Navaratnam, S.; Ngo, T.; Gunawardena, T.; Henderson, D. Performance Review of Prefabricated Building Systems and Future Research in Australia. *Buildings* **2019**, *9*, 38. [CrossRef]
226. Barros, P.; Fat, L.N.; Garcia, L.M.T.; Slovic, A.D.; Thomopoulos, N.; de Sá, T.H.; Morais, P.; Mindell, J.S. Social Consequences and Mental Health Outcomes of Living in High-Rise Residential Buildings and the Influence of Planning, Urban Design and Architectural Decisions: A Systematic Review. *Cities* **2019**, *93*, 263–272. [CrossRef]
227. Kalantari, S.; Shepley, M. Psychological and Social Impacts of High-Rise Buildings: A Review of the Post-Occupancy Evaluation Literature. *Hous. Stud.* **2021**, *36*, 1147–1176. [CrossRef]
228. Altomonte, S.; Saadouni, S.; Kent, M.G.; Schiavon, S. Satisfaction with Indoor Environmental Quality in BREEAM and Non-BREEAM Certified Office Buildings. *Archit. Sci. Rev.* **2017**, *60*, 343–355. [CrossRef]
229. Bozovic-Stamenovic, R.; Kishnani, N.; Tan, B.K.; Prasad, D.; Faizal, F. Assessment of Awareness of Green Mark (GM) Rating Tool by Occupants of GM Buildings and General Public. *Energy Build.* **2016**, *115*, 55–62. [CrossRef]
230. Chokor, A.; El Asmar, M. A Novel Modeling Approach to Assess the Electricity Consumption of LEED-Certified Research Buildings Using Big Data Predictive Methods. In Proceedings of the Construction Research Congress 2016, San Juan, Puerto Rico, 31 May–2 June 2016; American Society of Civil Engineers: San Juan, Puerto Rico, 2016; pp. 1040–1049.
231. Doan, D.T.; Ghaffarianhoseini, A.; Naismith, N.; Ghaffarianhoseini, A.; Zhang, T.; Tookey, J. Examining Green Star Certification Uptake and Its Relationship with Building Information Modelling (BIM) Adoption in New Zealand. *J. Environ. Manag.* **2019**, *250*, 109508. [CrossRef] [PubMed]
232. Hu, M. 2019 Energy Benchmarking Data for LEED-Certified Buildings in Washington, D.C.: Simulation and Reality. *J. Build. Eng.* **2021**, *42*, 102475. [CrossRef]
233. Suzer, O. Analyzing the Compliance and Correlation of LEED and BREEAM by Conducting a Criteria-Based Comparative Analysis and Evaluating Dual-Certified Projects. *Build. Environ.* **2019**, *147*, 158–170. [CrossRef]
234. Wong, S.-C.; Abe, N. Stakeholders' Perspectives of a Building Environmental Assessment Method: The Case of CASBEE. *Build. Environ.* **2014**, *82*, 502–516. [CrossRef]
235. Ye, L.; Cheng, Z.; Wang, Q.; Lin, H.; Lin, C.; Liu, B. Developments of Green Building Standards in China. *Renew. Energy* **2015**, *73*, 115–122. [CrossRef]
236. Benn, M.; Stoy, C. BIM for CREM: Exploring the Benefit of Building Information Modelling for Facility Management in Corporate Real Estate Management. *Buildings* **2022**, *12*, 400. [CrossRef]
237. Brem, A.; Cusack, D.Ó.; Adrita, M.M.; O'Sullivan, D.T.J.; Bruton, K. How Do Companies Certified to ISO 50001 and ISO 14001 Perform in LEED and BREEAM Assessments? *Energy Effic.* **2020**, *13*, 751–766. [CrossRef]
238. Pedro, J.; Silva, C.; Pinheiro, M.D. Integrating GIS Spatial Dimension into BREEAM Communities Sustainability Assessment to Support Urban Planning Policies, Lisbon Case Study. *Land Use Policy* **2019**, *83*, 424–434. [CrossRef]
239. Serrano-Baena, M.M.; Triviño-Tarradas, P.; Ruiz-Díaz, C.; Fernández, R.E.H. Implications of BREEAM Sustainability Assessment on the Design of Hotels. *Sustainability* **2020**, *12*, 6550. [CrossRef]
240. Umdu, D.C.; Alakavuk, E.; Koyuncu, A. BREEAM Communities: Criteria Aim, Status, Strengths and Weaknesses. In Proceedings of the 2021 International Conference on Digital Age & Technological Advances for Sustainable Development (ICDATA), IEEE. Marrakech, Morocco, 29–30 June 2021; pp. 208–215.
241. Darko, A.; Zhang, C.; Chan, A.P.C. Drivers for Green Building: A Review of Empirical Studies. *Habitat Int.* **2017**, *60*, 34–49. [CrossRef]
242. Feng, Q.; Chen, H.; Shi, X.; Wei, J. Stakeholder Games in the Evolution and Development of Green Buildings in China: Government-Led Perspective. *J. Clean. Prod.* **2020**, *275*, 122895. [CrossRef]
243. Huo, X. Analytical Review of Green Building Stakeholders in China. In *Green Building in Developing Countries*; Gou, Z., Ed.; Green Energy and Technology; Springer International Publishing: Cham, Switzerland, 2020; pp. 23–32. ISBN 978-3-030-24649-5.
244. Song, Y.; Li, C.; Zhou, L.; Huang, X.; Chen, Y.; Zhang, H. Factors Affecting Green Building Development at the Municipal Level: A Cross-Sectional Study in China. *Energy Build.* **2021**, *231*, 110560. [CrossRef]
245. Arif, M.; Bendi, D.; Toma-Sabbagh, T.; Sutrisna, M. Construction Waste Management in India: An Exploratory Study. *Constr. Innov.* **2012**, *12*, 133–155. [CrossRef]
246. Khoshnava, S.M.; Rostami, R.; Ismail, M.; Lamit, H. Obstacles and Drivers in Steering IBS towards Green and Sustainability. *Res. J. Appl. Sci. Eng. Technol.* **2014**, *8*, 1639–1647. [CrossRef]
247. Qian, Q.K.; Fan, K.; Chan, E.H.W. Regulatory Incentives for Green Buildings: Gross Floor Area Concessions. *Build. Res. Inf.* **2016**, *44*, 675–693. [CrossRef]
248. Li, J.; Shui, B. A Comprehensive Analysis of Building Energy Efficiency Policies in China: Status Quo and Development Perspective. *J. Clean. Prod.* **2015**, *90*, 326–344. [CrossRef]
249. Fu, J.; Geng, Y. Public Participation, Regulatory Compliance and Green Development in China Based on Provincial Panel Data. *J. Clean. Prod.* **2019**, *230*, 1344–1353. [CrossRef]
250. Wang, J.; He, B.-J.; Wang, H.; Santamouris, M. Towards Higher Quality Green Building Agenda—An Overview of the Application of Green Building Techniques in China. *Sol. Energy* **2019**, *193*, 473–493. [CrossRef]
251. Darko, A.; Chan, A.P.C.; Ameyaw, E.E.; He, B.-J.; Olanipekun, A.O. Examining Issues Influencing Green Building Technologies Adoption: The United States Green Building Experts' Perspectives. *Energy Build.* **2017**, *144*, 320–332. [CrossRef]

252. Darko, A.; Chan, A.P.C.; Yang, Y.; Shan, M.; He, B.-J.; Gou, Z. Influences of Barriers, Drivers, and Promotion Strategies on Green Building Technologies Adoption in Developing Countries: The Ghanaian Case. *J. Clean. Prod.* **2018**, *200*, 687–703. [CrossRef]
253. Geng, Y.; Dong, H.; Xue, B.; Fu, J. An Overview of Chinese Green Building Standards: Chinese Green Building Standards. *Sustain. Dev.* **2012**, *20*, 211–221. [CrossRef]
254. Liu, Z.; Wu, D.; He, B.-J.; Liu, Y.; Zhang, X.; Yu, H.; Jin, G. Using Solar House to Alleviate Energy Poverty of Rural Qinghai-Tibet Region, China: A Case Study of a Novel Hybrid Heating System. *Energy Build.* **2018**, *178*, 294–303. [CrossRef]
255. Muller, M.F.; Esmanioto, F.; Huber, N.; Loures, E.R.; Canciglieri, O. A Systematic Literature Review of Interoperability in the Green Building Information Modeling Lifecycle. *J. Clean. Prod.* **2019**, *223*, 397–412. [CrossRef]
256. Xie, X.; Gou, Z. Obstacles of Implementing Green Building in Architectural Practices. In *Green Building in Developing Countries*; Gou, Z., Ed.; Green Energy and Technology; Springer International Publishing: Cham, Switzerland, 2020; pp. 33–47. ISBN 978-3-030-24649-5.
257. Chen, S.; Jin, R.; Alam, M. Investigation of Interoperability between Building Information Modelling (BIM) and Building Energy Simulation (BES). *Int. Rev. Appl. Sci. Eng.* **2018**, *9*, 137–144. [CrossRef]
258. Liu, Y.; Hong, Z.; Zhu, J.; Yan, J.; Qi, J.; Liu, P. Promoting Green Residential Buildings: Residents' Environmental Attitude, Subjective Knowledge, and Social Trust Matter. *Energy Policy* **2018**, *112*, 152–161. [CrossRef]